



Florida Department of Transportation

605 Suwannee Street

Tallahassee, FL 32399-0450

FDOTConnect
MSE RETAINING WALL
EXAMPLE WORKFLOWS
BENTLEY'S OPENROADS DESIGNER CE

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FDOTConnectXX.XX OpenRoads Designer Training: MSE Retaining Wall Example Workflows

Wall Design & Modeling

Description

This training course details 3D wall modeling workflow using Bentley product OpenRoads Designer (ORD). To be in compliance with Florida Department of Transportation CADD standard (FDOT CADD), this effort must also be accomplished within FDOTConnectXX.XX workspace. Starting with setting up a MSE wall at a bridge wraparound and along a roadway corridor, following up with setting leveling pad elevations, and concluding with quantity extraction from the model, the participant is walked through a typical workflow using the tools and features available.

In the following workflow guide, wall modeling is completed in a standalone .dgn file; however, the same processes may be completed within an existing roadway corridor model. When considering whether to use a standalone file or the roadway corridor model for wall model creation and maintenance, users should act according to their own overall model management plan.

Please note that this workflow is just an example, and values, dimensions, etc. will vary based on your project specific data. The user will need their own project data, including proposed horizontal & vertical roadway geometry, an existing ground terrain model surface, and an OBM bridge model.

Objectives

This document aids users through the wall modeling process and includes the following topics:

- Modeling a Wraparound MSE Retaining Wall using OpenRoads Designer and the FDOT ORD Workspace with ORD detail modeling techniques. An OpenBridge Modeler Skewed 3D Bridge Model is used as a reference.
- Modeling a Roadway MSE Retaining Wall using OpenRoads Designer and the FDOT ORD Workspace.
- Applying a profile to control the elevation of the Retaining Wall leveling pad.
- Utilizing template/corridor meshes to extract Retaining Wall quantity information.

Prerequisites

This workflow guide assumes that the user has background knowledge of the Bentley ORD and/or the OBM software, FDOTConnect Workspace Software and training guides.

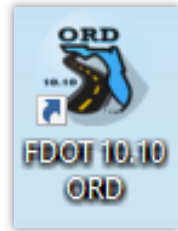
EXERCISE OVERVIEW

- Exercise 1.1 Create an MSE Wall Bridge Wraparound..... [1](#)
- Exercise 1.2 Create a Roadway MSE Wall for the Roadway Backbone Corridor..... [38](#)
- Exercise 1.3 Create a Variable Depth MSE Wall Leveling Pad..... [48](#)
- Exercise 1.4 Extract MSE Wall Quantities from Model Data..... [56](#)

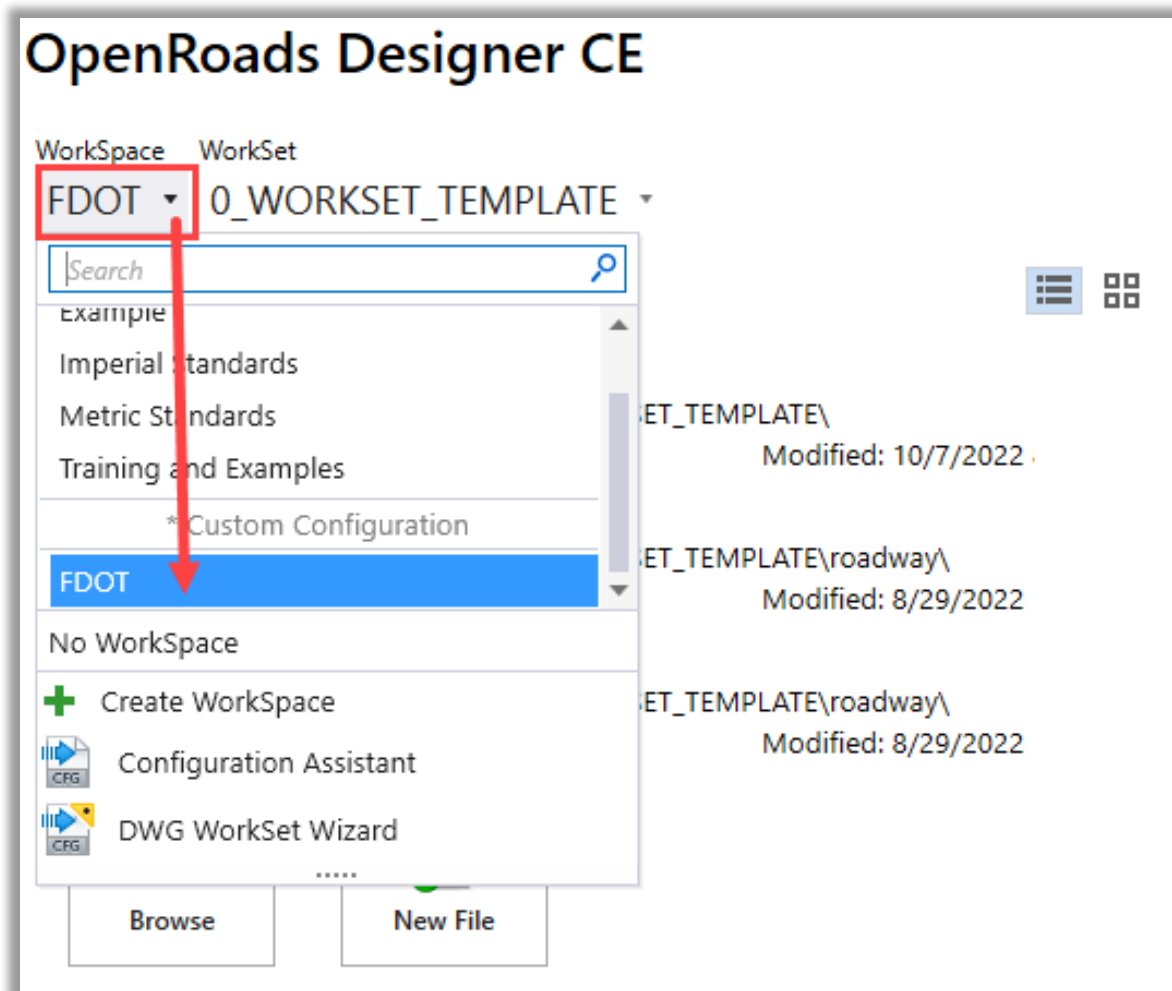
Exercise 1.1 Create an MSE Wall Bridge Wraparound

➤ **Create Plan and Profile Elements as Reference for Wall Coping:**

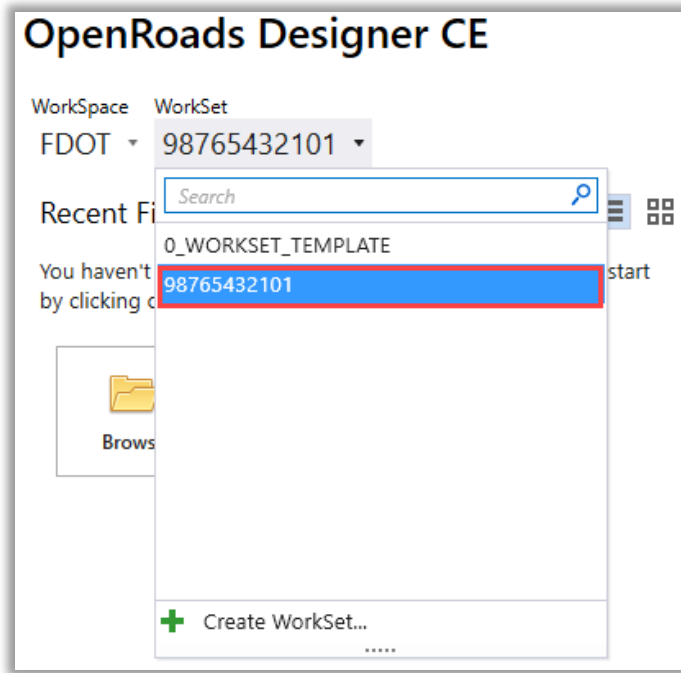
1. Open FDOTConnect for ORD by using the FDOT ORD shortcut on your desktop:



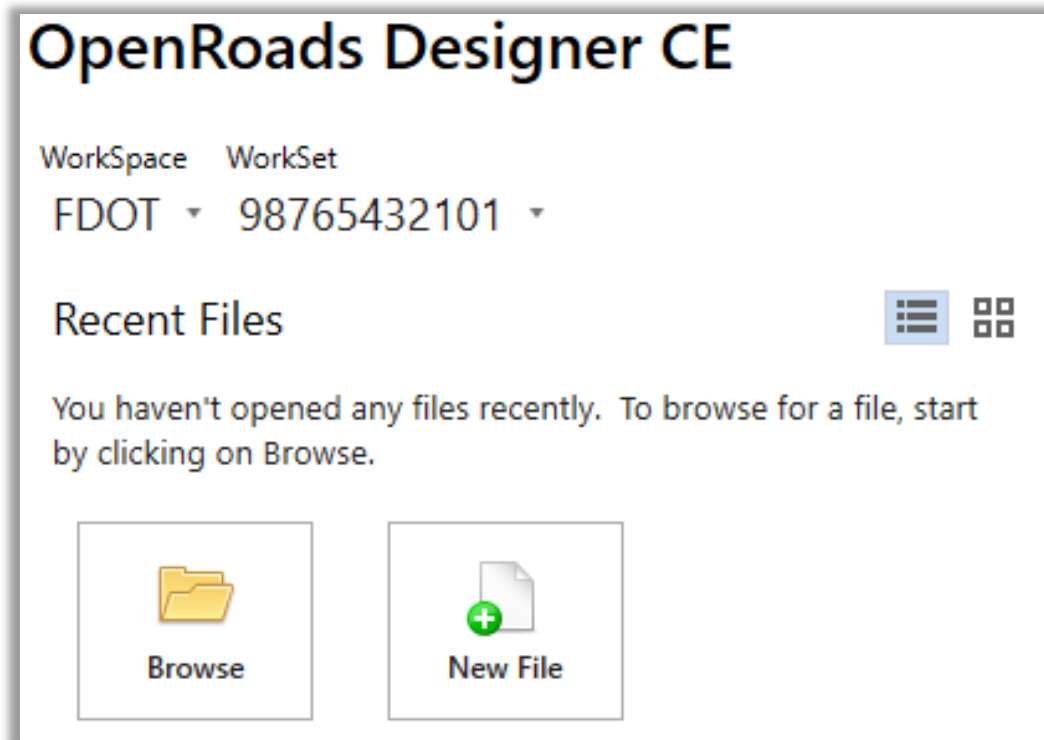
2. Set the Workspace to "FDOT":



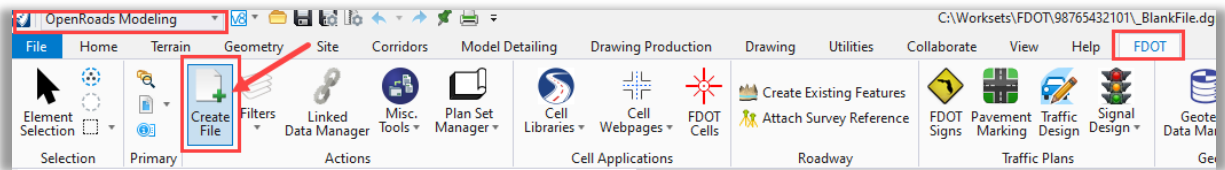
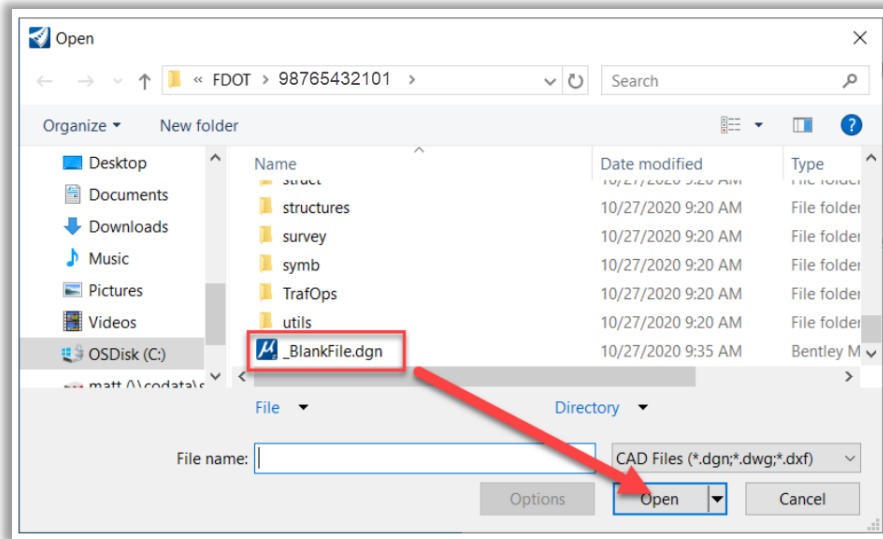
3. Create or Select the WorkSet (Project). When creating a new WorkSet, the template **O_WORKSET_TEMPLATE** should be selected.



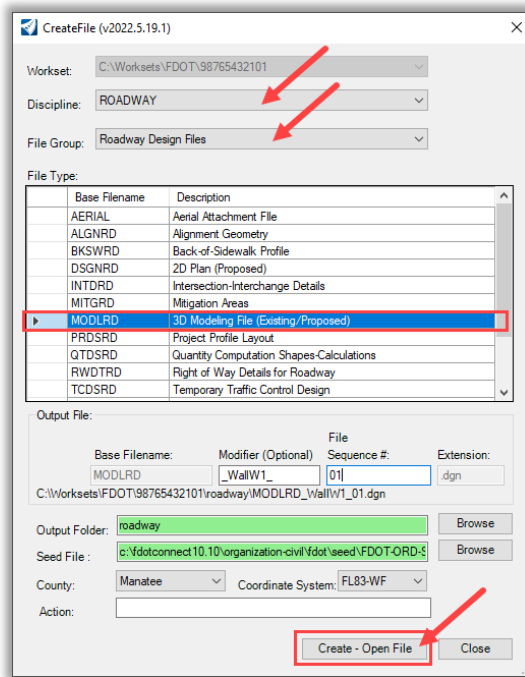
4. Confirm the correct WorkSpace & WorkSet for your project:



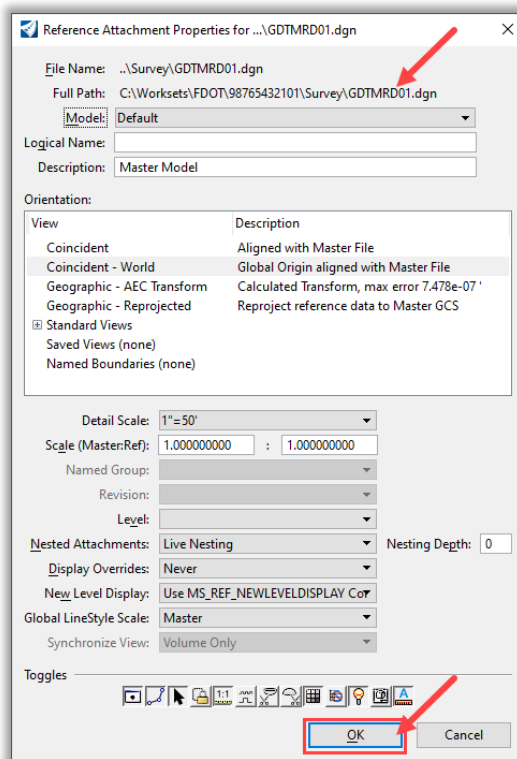
5. Select a file from Recent Files, browse for a file, or create a New File by browsing to the **_BlankFile.dgn** & use the **Create File** Tool under the **FDOT** menu:



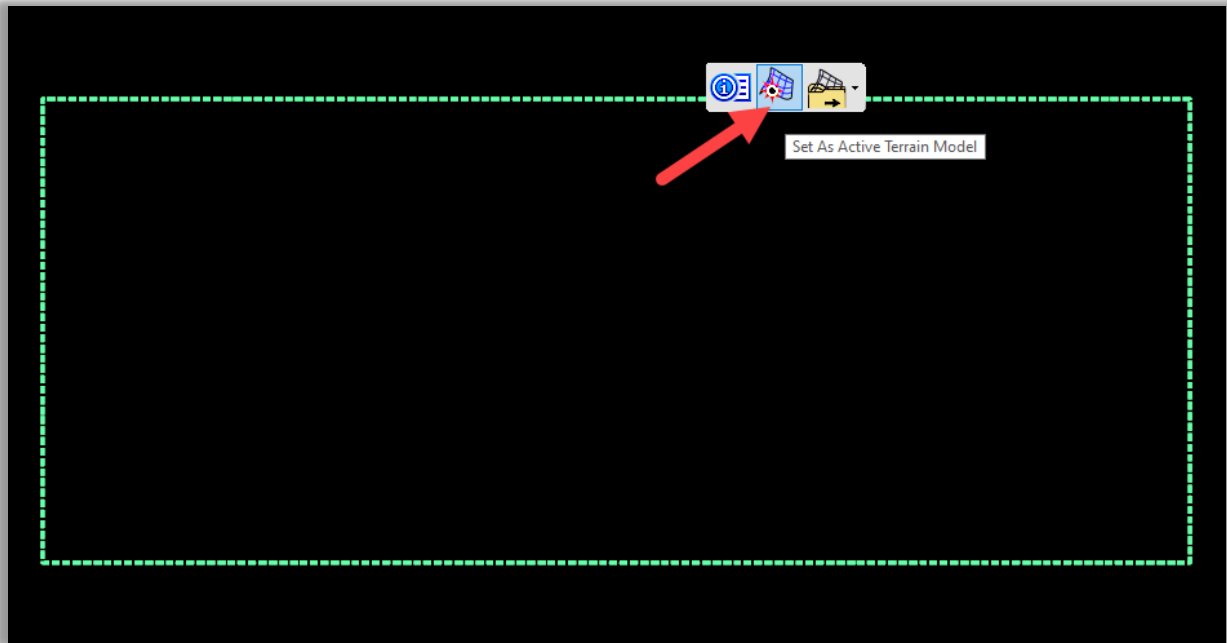
- Select or Create your MSE Wall model file. For this example, we will create & use **MODLRD_WallW1_01.dgn**



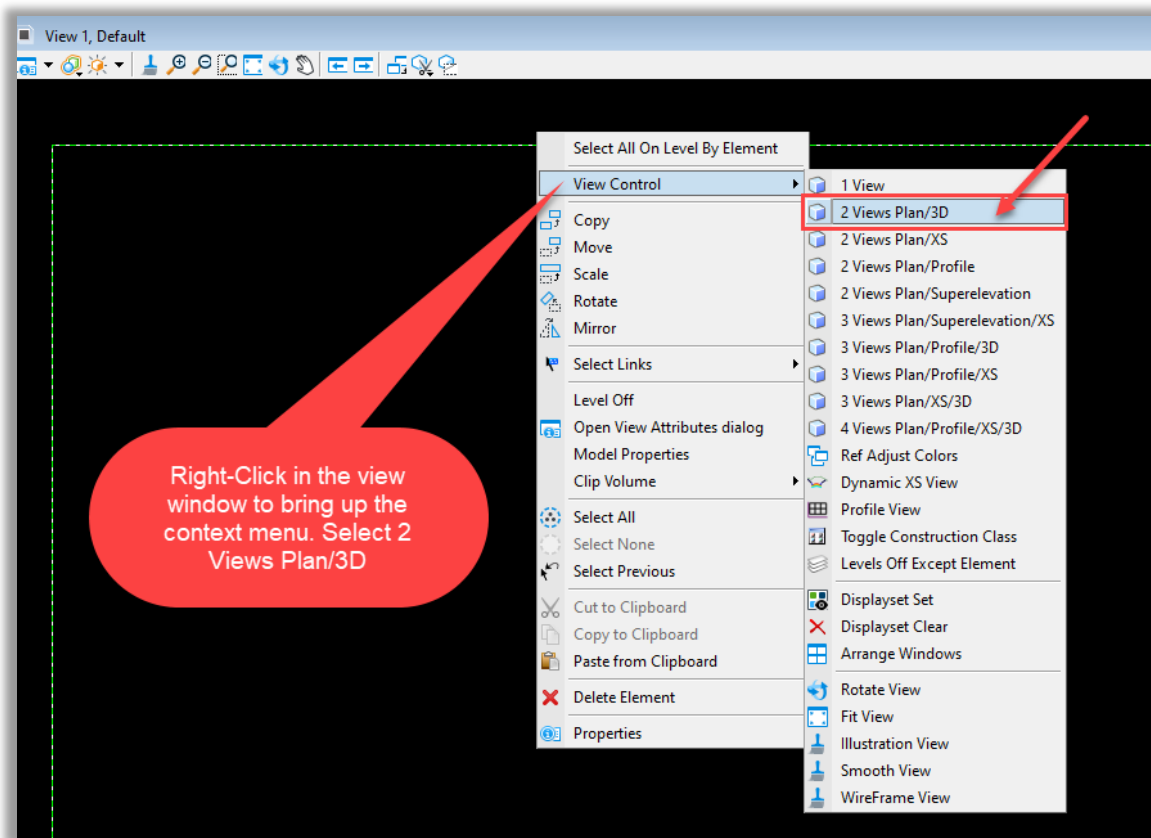
- Prepare the file to model the MSE Wall Bridge Wraparound by attaching the existing ground terrain model, **GDTMRD01.dgn**.



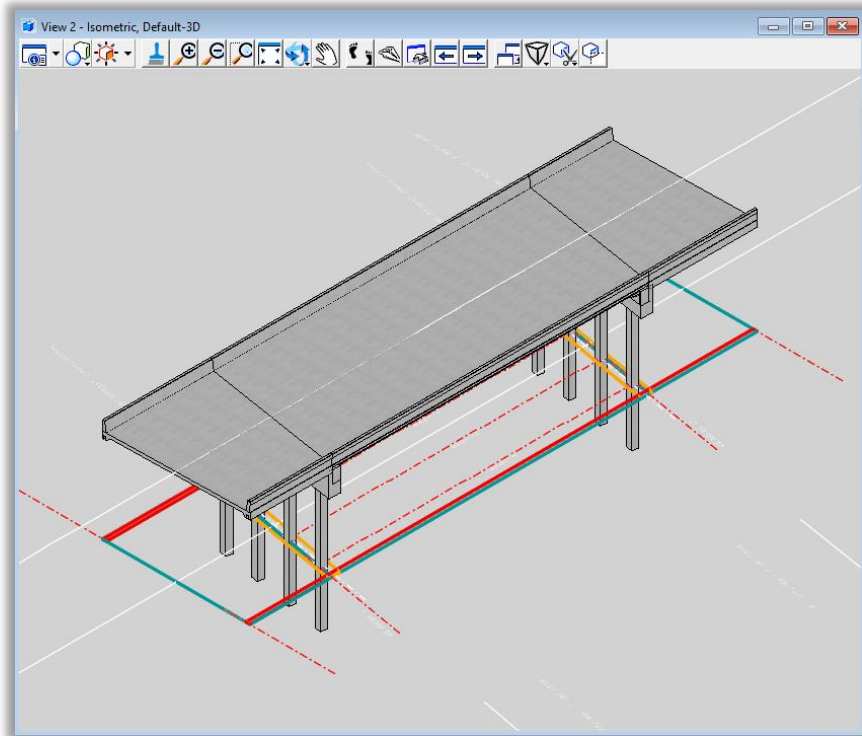
8. Set the terrain as active to create the 3D model in the current design file.



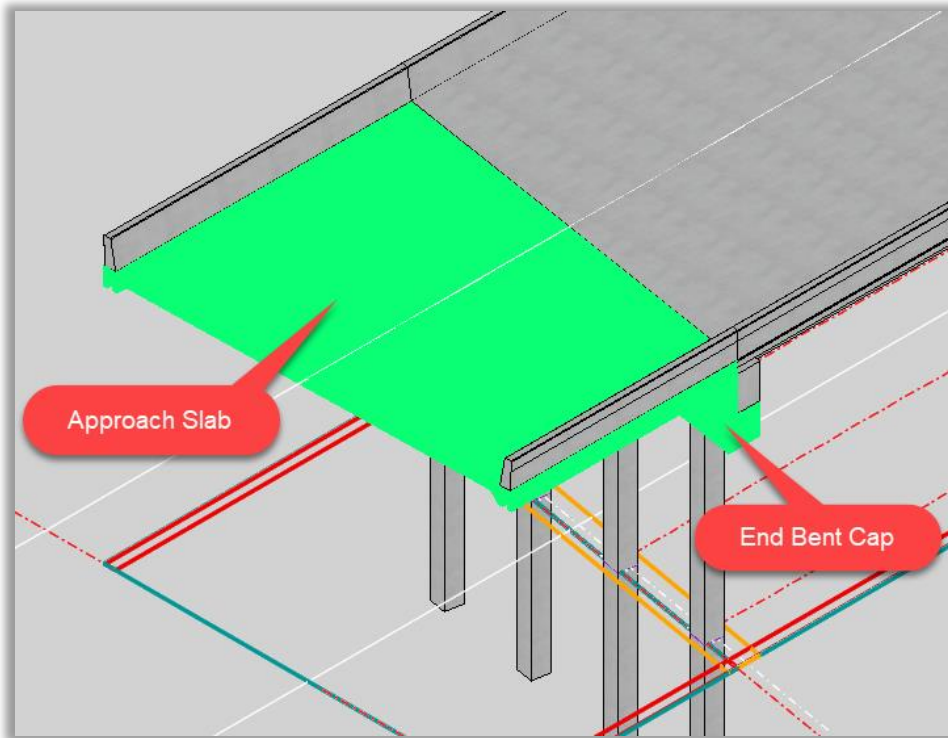
9. Open the 3D View.



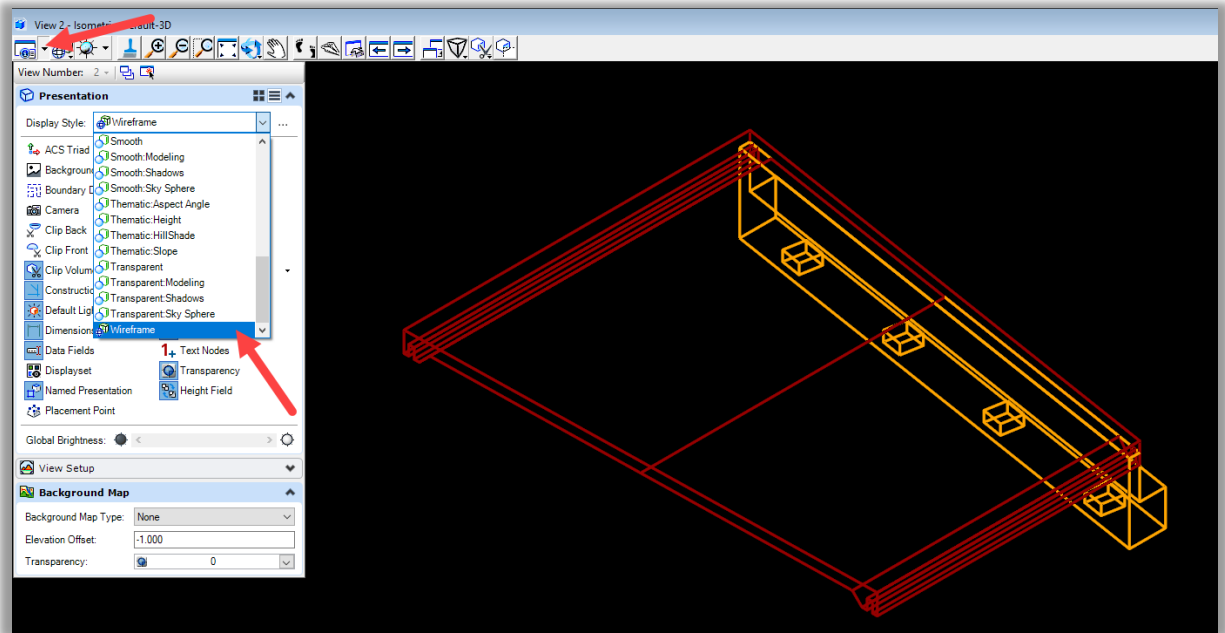
10. Attach the OBM 3D Bridge file to your 3D view model.



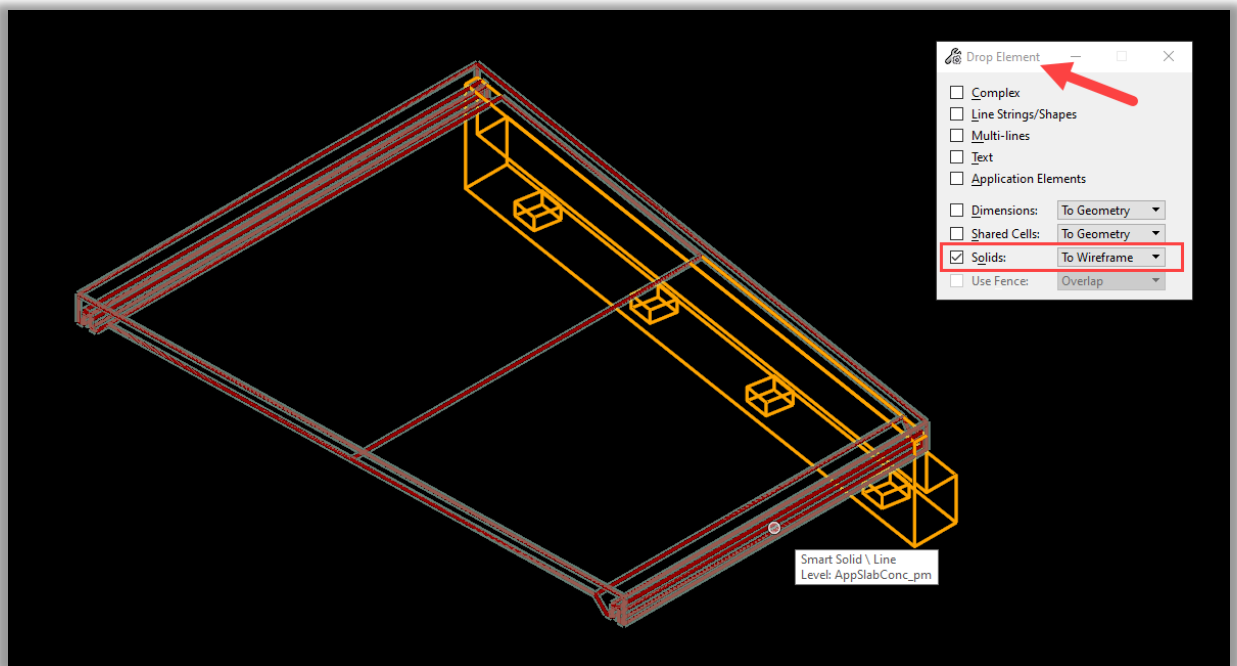
11. Copy referenced OBM solids into the 3D view. Then, select the Bridge Approach Slab & End Bent Cap.



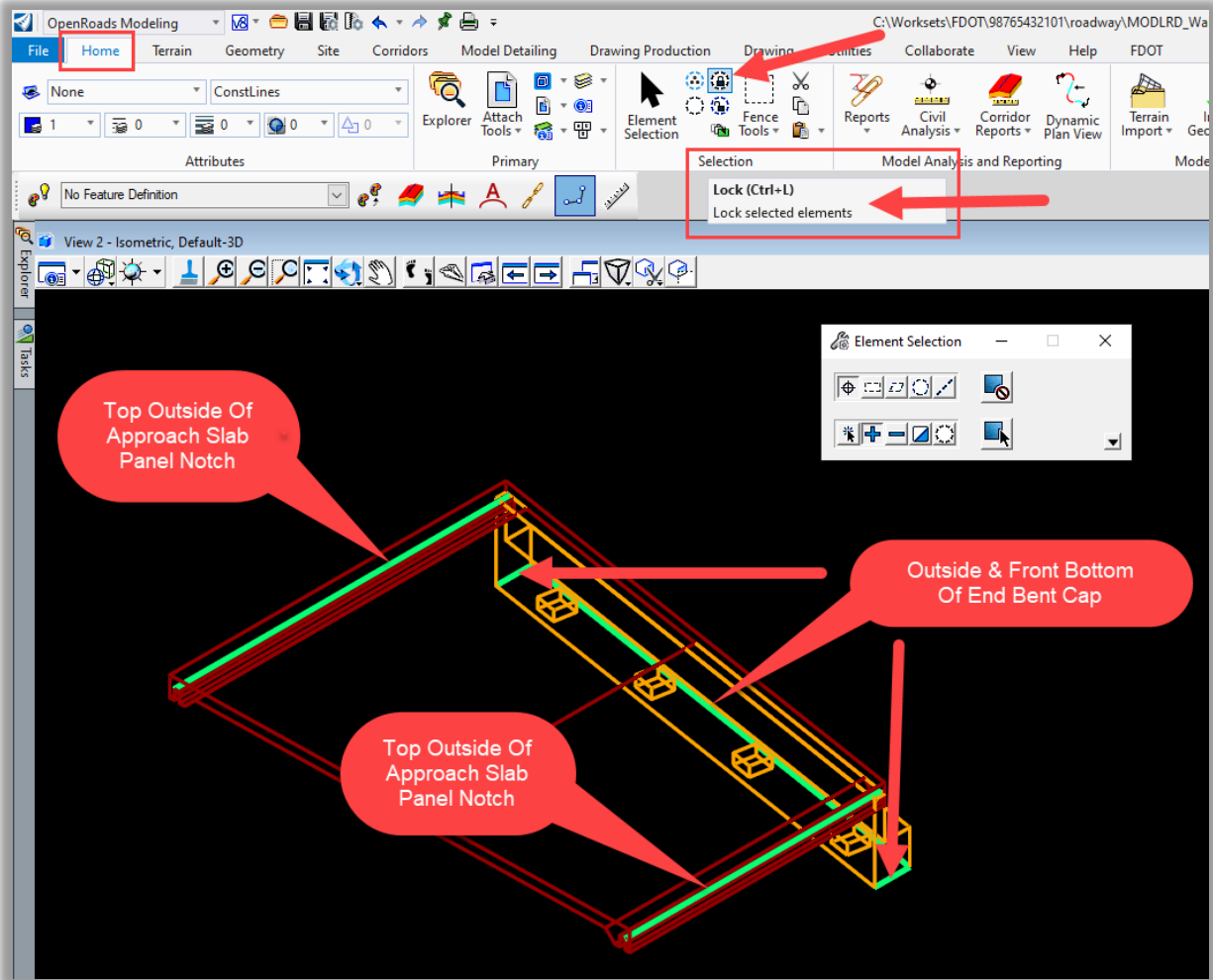
12. Change the presentation of the 3D view by choosing the Wireframe Display Style.



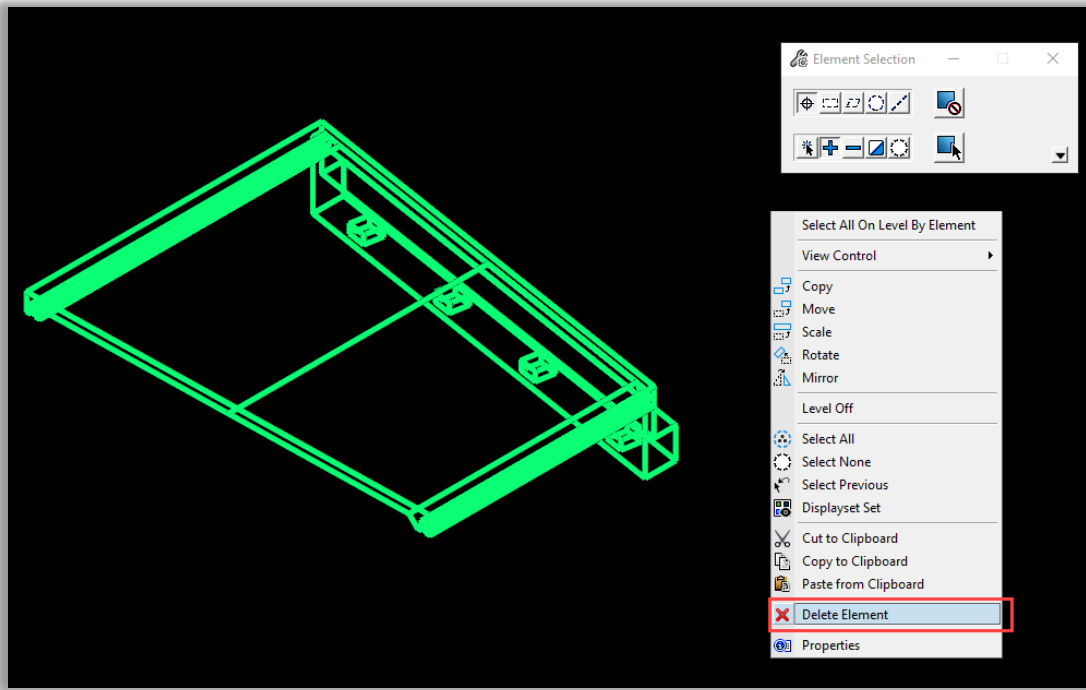
13. Drop the OBM solids to wireframe by using the Drop Element tool.



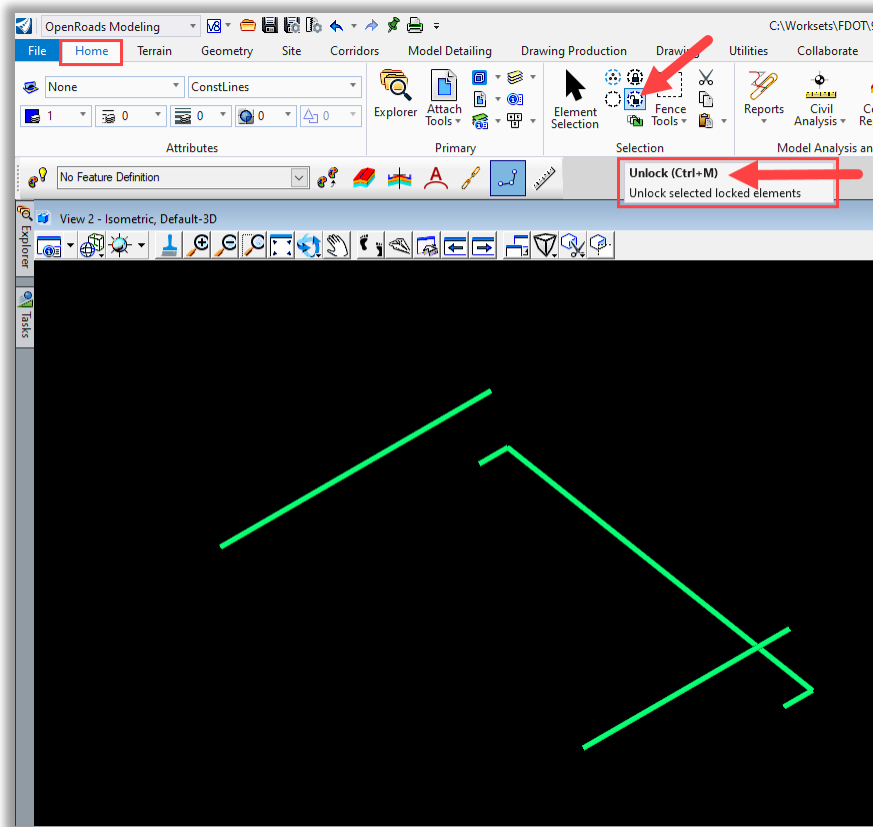
14. Select & Lock the Solids edges. Lock the solids elements to be used for Linear Template Geometry.
 - a. Top Outside of the Approach Slab Panel Notch.
 - b. Outside & Front Bottom of the End Bent Cap.



15. Select & Delete all unlocked edges.

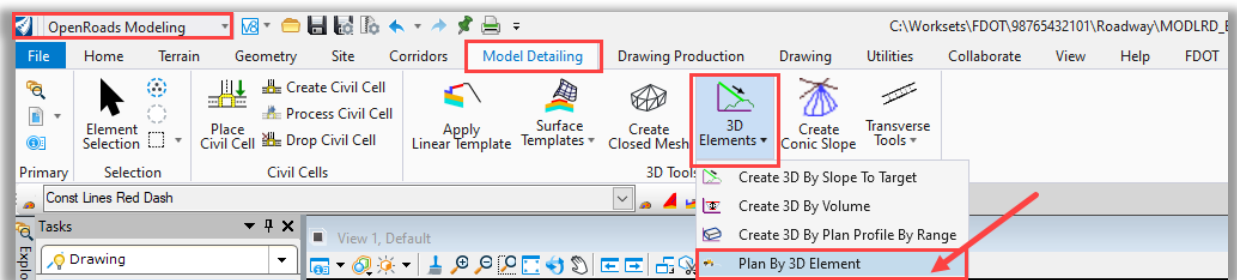


16. Unlock the remaining 3D solid edges.

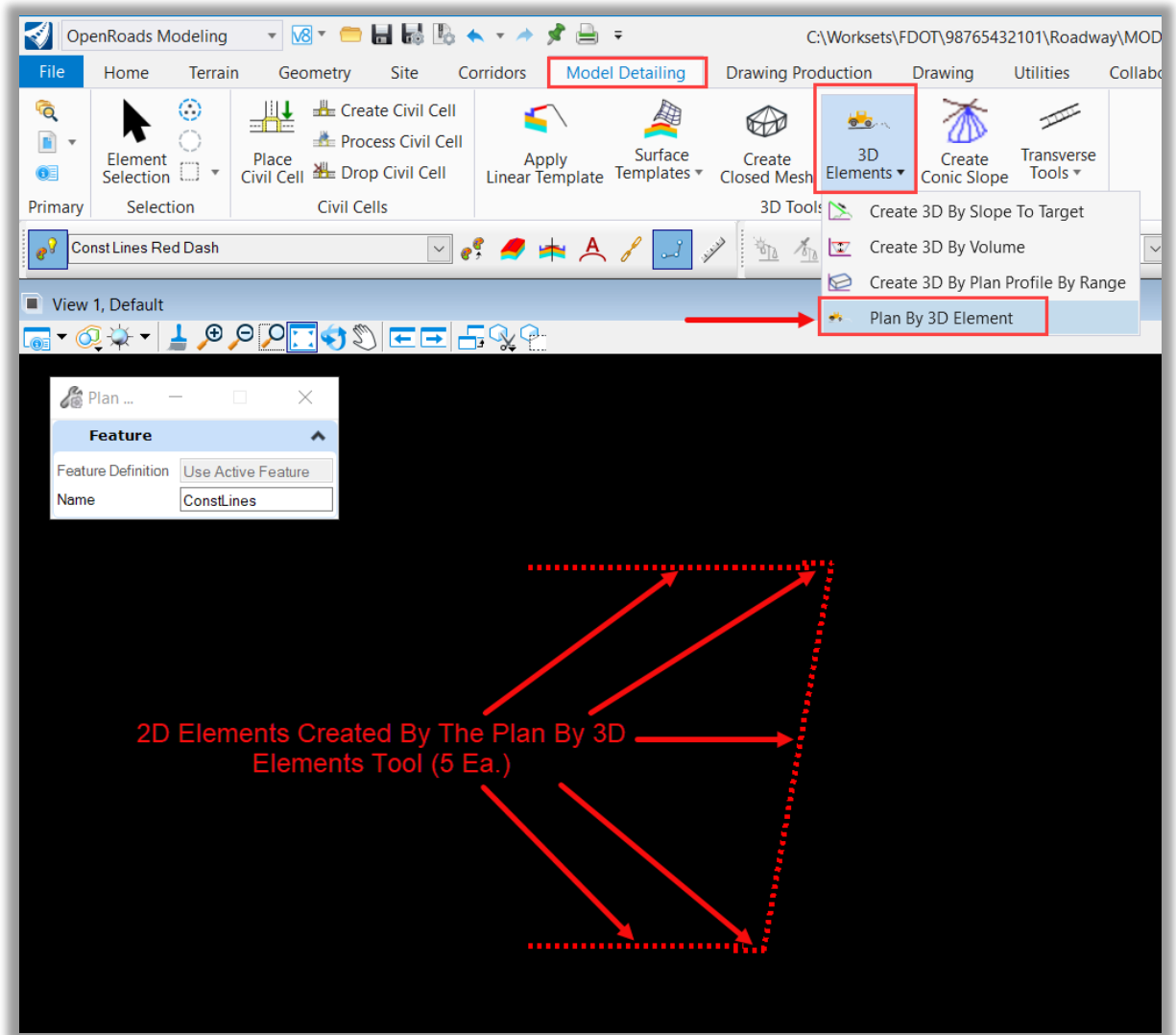


17. Create Plan By 3D Element:

- a. Set the Active Feature Definition to “Const Lines Red Dash.”
- b. Select the individual 3D Solids Edges one at a time.
- c. Elements will show in the 2D Default View.

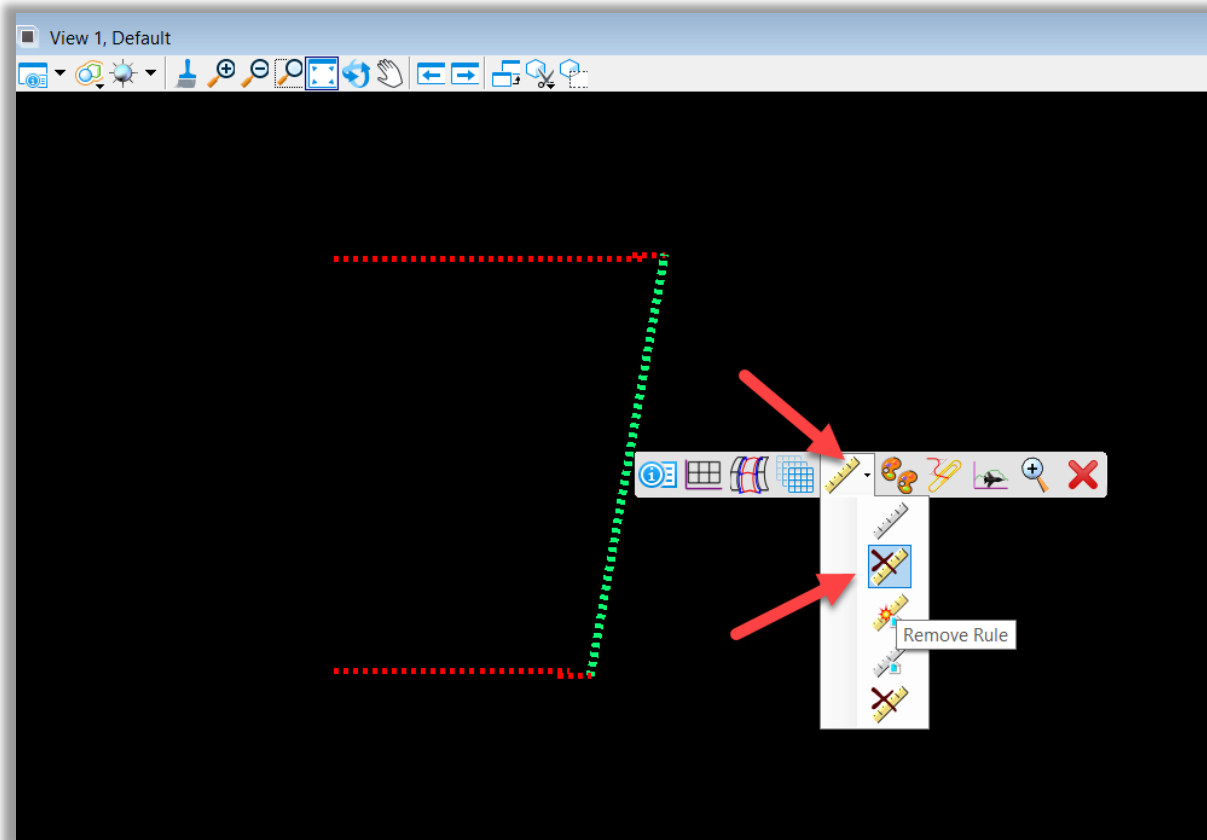


d. Elements will show in the 2D Default View.



18. Prepare the 2D Plan elements:

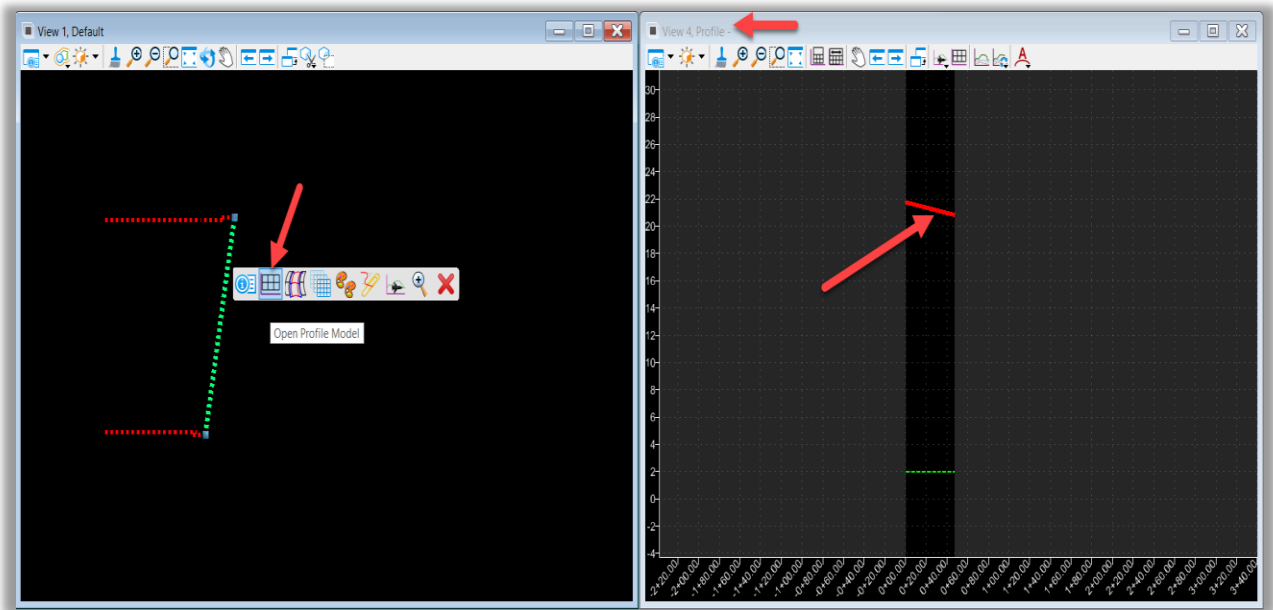
- a. Begin by removing the rules from all 2D Plan elements.
- b. Select the Plan View Element from the previous step and hover over the element to open the civil context popup menu bar.
- c. Use the civil context popup to remove the rules.



19. Repeat the process for the remaining 4 Plan View Elements.

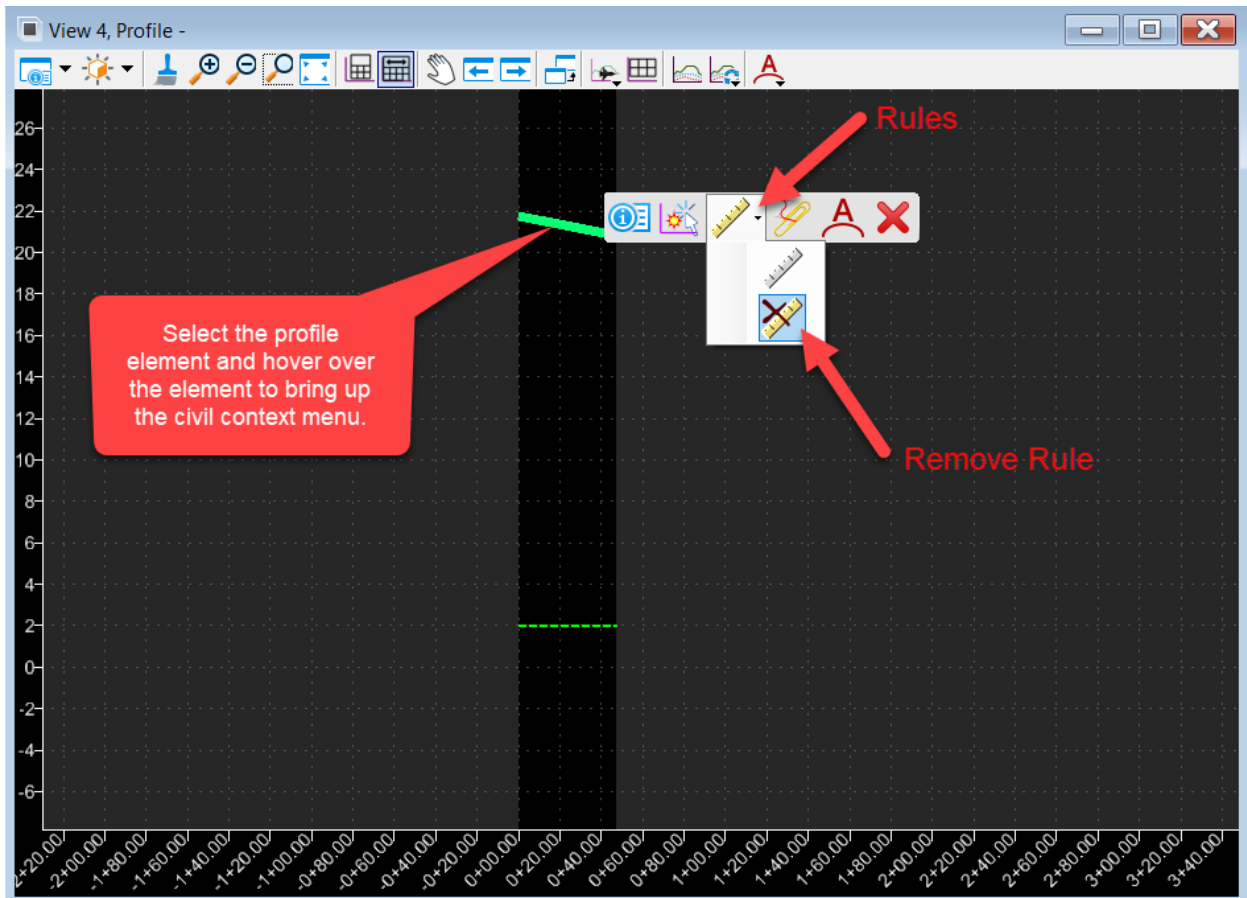
20. Prepare the Profile Elements:

- a. Select the Plan View Element from the previous step and hover over the element to open the civil context popup menu bar.
- b. Choose “Open Profile Model” from the context popup menu.
- c. Following the prompts in the lower left-hand corner of ORD, open View 4 and select inside the view window to view the profile.

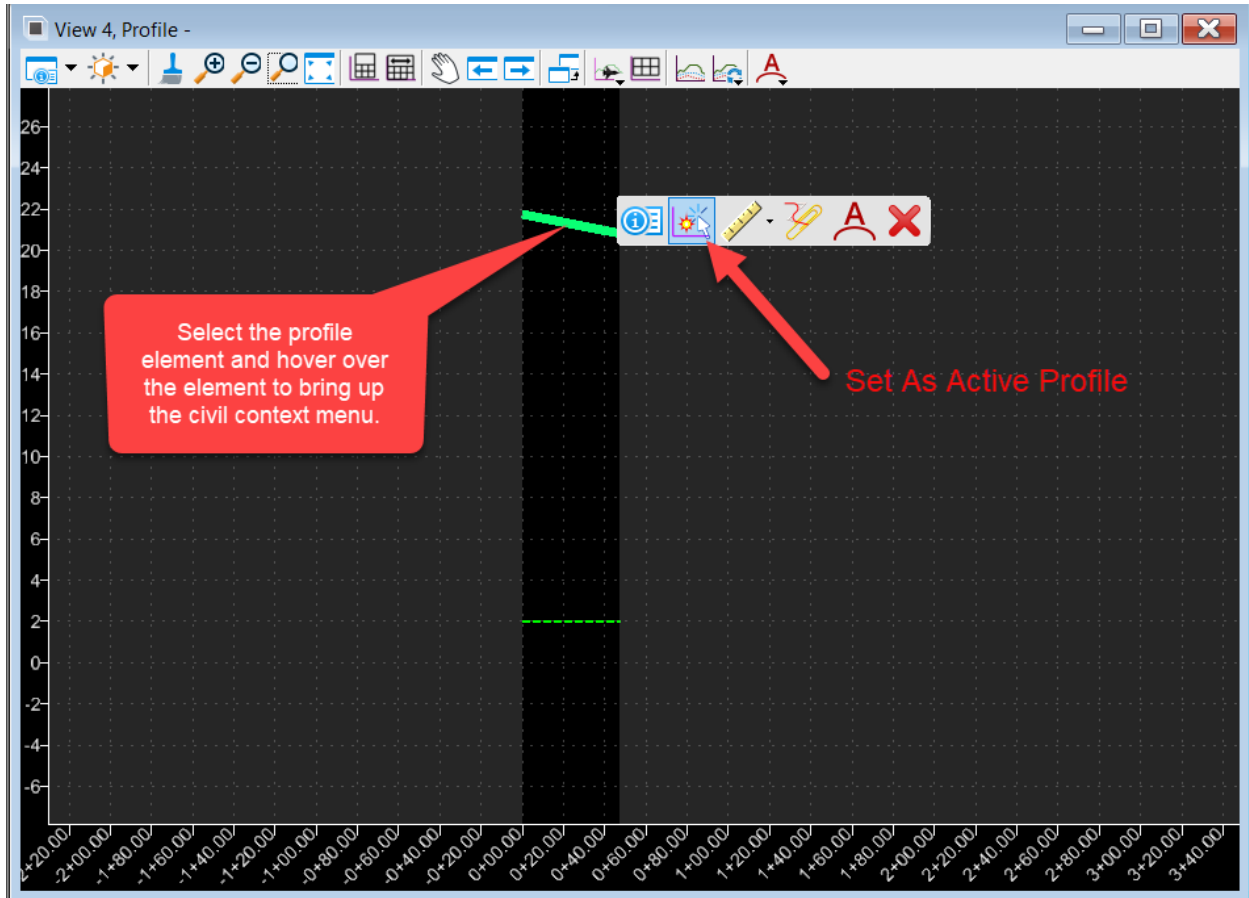


21. Remove the rules from the Profile Elements:

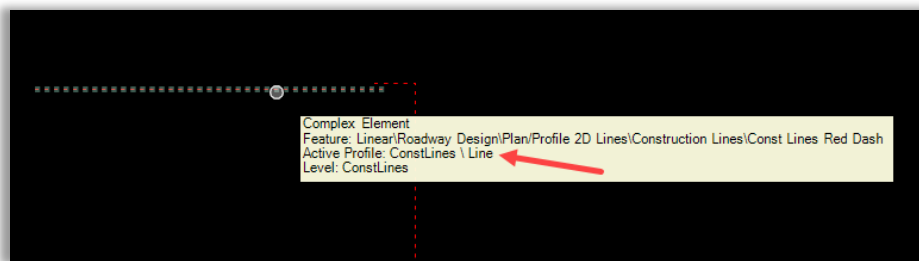
- a. Select the profile element, and hover over the element to open the civil context popup menu bar.
- b. Use the civil context popup to remove the rules. Note: It is very important to first remove the rules from the Proposed Profile Elements before setting the Active Profile. Not doing so will cause the Active Profile not to “set” or work as expected.



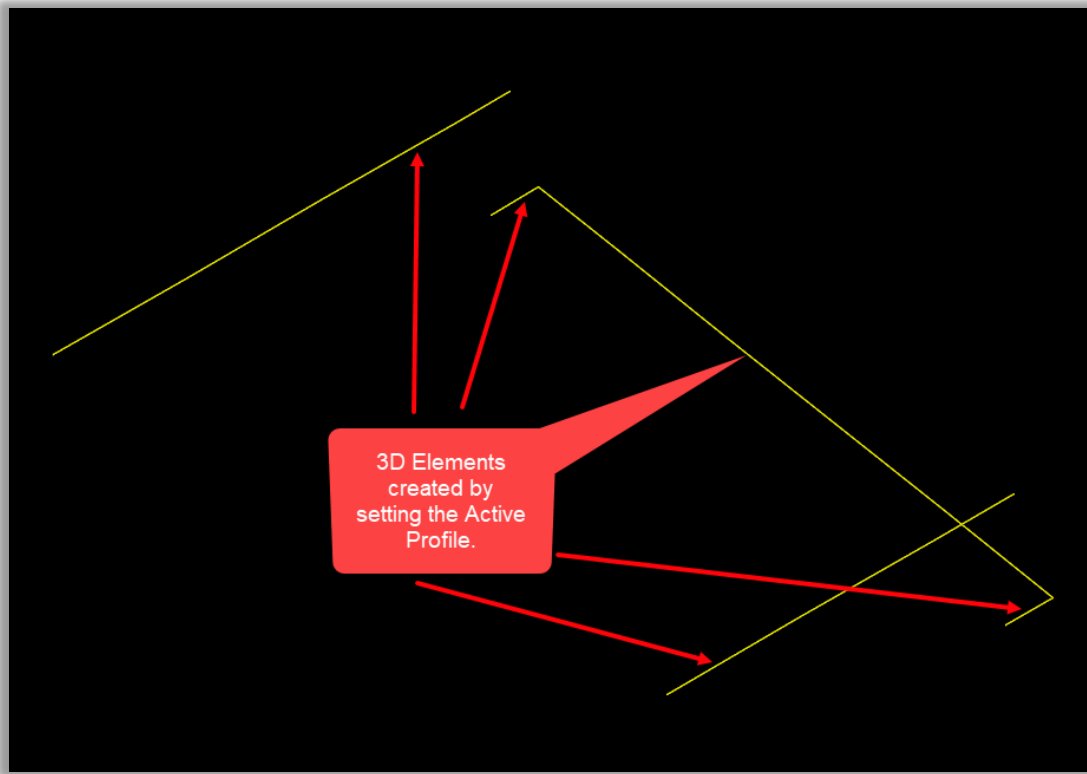
22. Select the profile element, and hover over the element to open the civil context popup menu bar. Select the tool "Set as Active Profile."



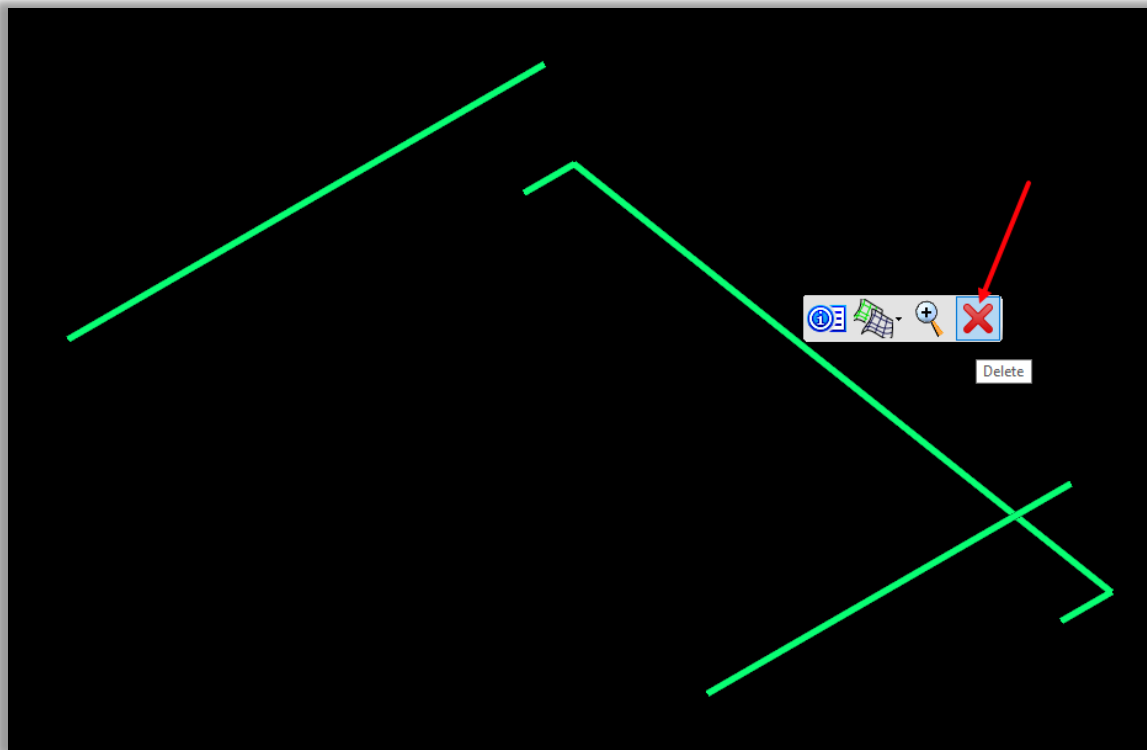
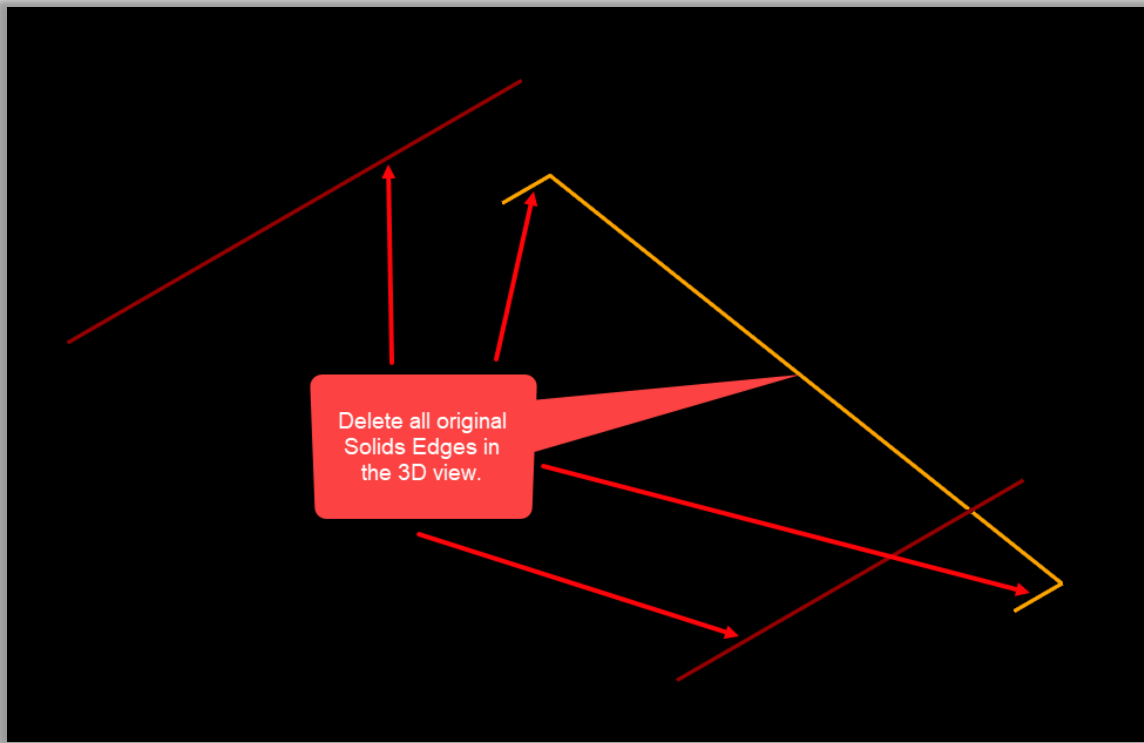
23. Repeat the process for the remaining 4 profile elements. Then, confirm the Active Profile for all 5 Horizontal Geometry (Plan View) Elements by hovering over each element.



24. Confirm the new 3D elements that were created by setting the active profile.

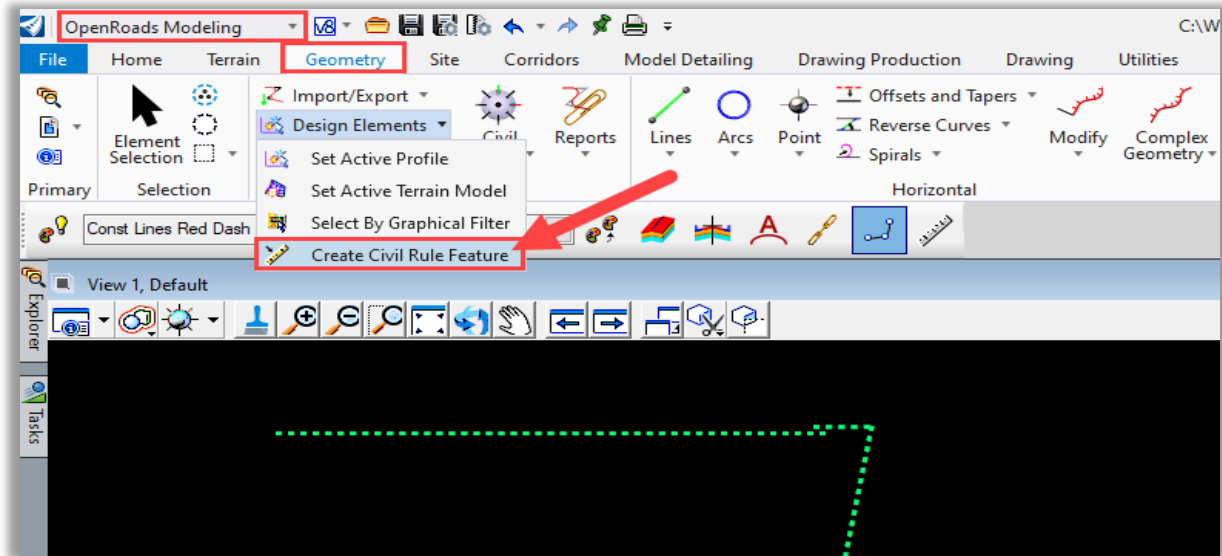


25. Delete all original Solids Edges in the 3D view. Select the elements from the End Bent Cap & the Approach Slab and delete.



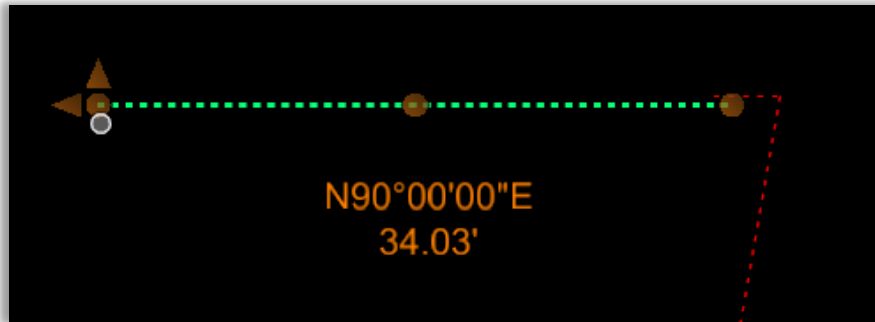
26. Create the Civil Rule Features (Horizontal):

- a. Select the 5 Horizontal Geometry (Plan View) Elements.
- b. Choose **Geometry > General Tools > Design Elements > Create Civil Rule Feature**.



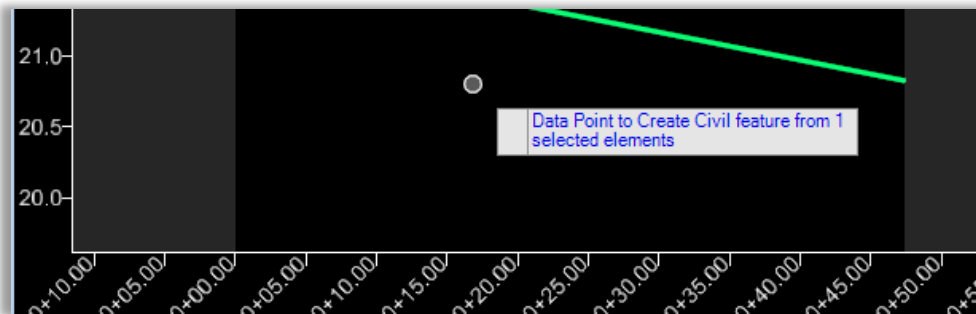
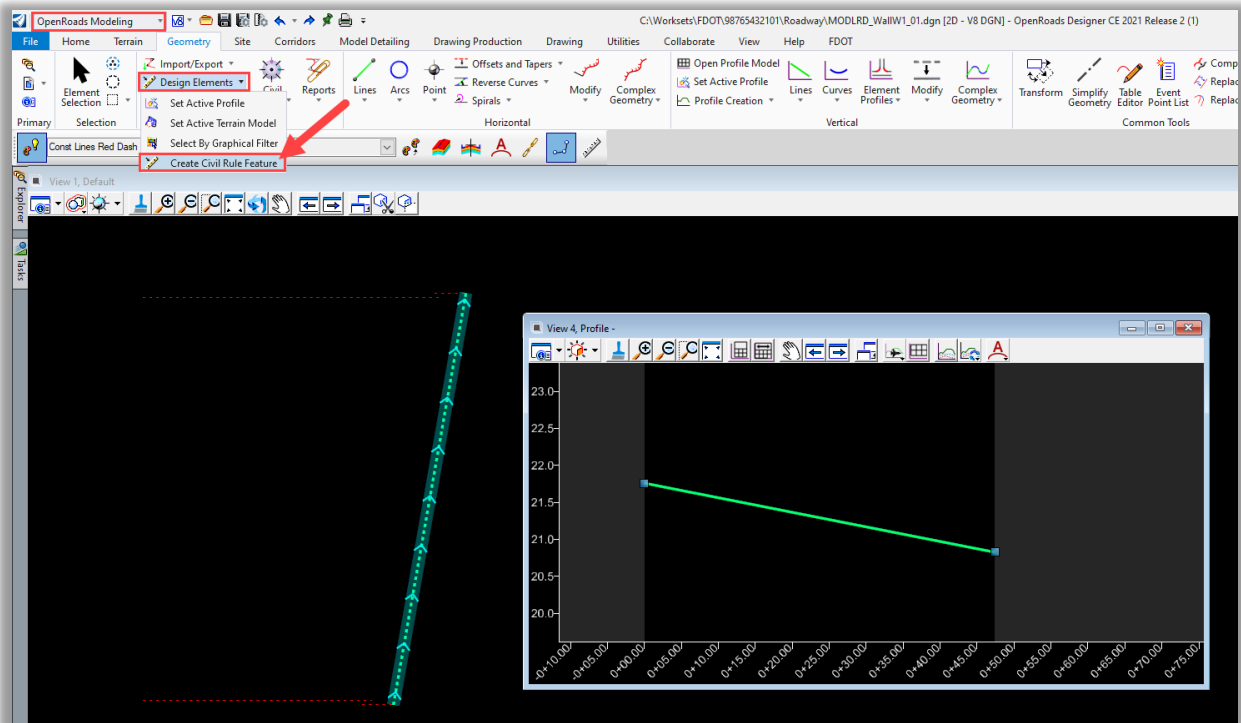
Data Point to Create Civil feature from 5 selected elements

27. Confirm the Civil Rules for all Horizontal Geometry.



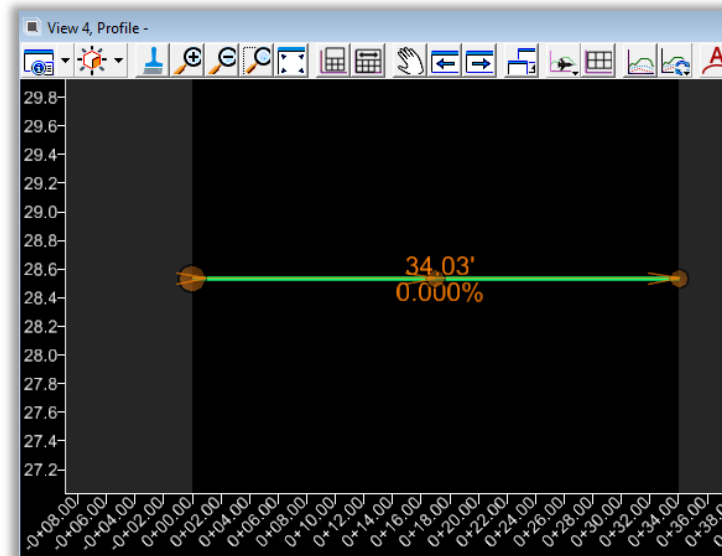
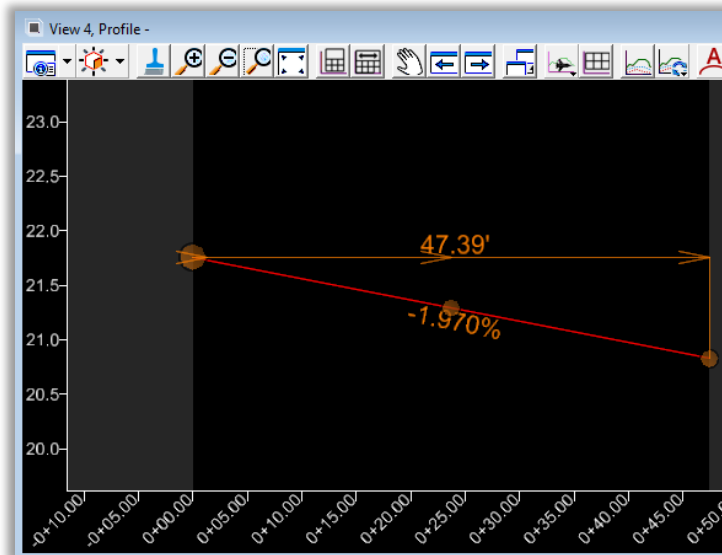
28. Create the Civil Rule Features (Vertical):

- a. Select any one of the 5 Horizontal Geometry (Plan View) Elements and hover over the element to open the civil context popup menu.
- b. Choose “Open Profile Model” from the context popup menu.
- c. Open the Profile View Model and then select the Vertical Geometry Active Profile Element.
- d. Choose **Geometry > General Tools > Design Elements > Create Civil Rule Feature**.



29. Repeat the process for the 4 remaining Vertical Geometry Active Profile Elements.

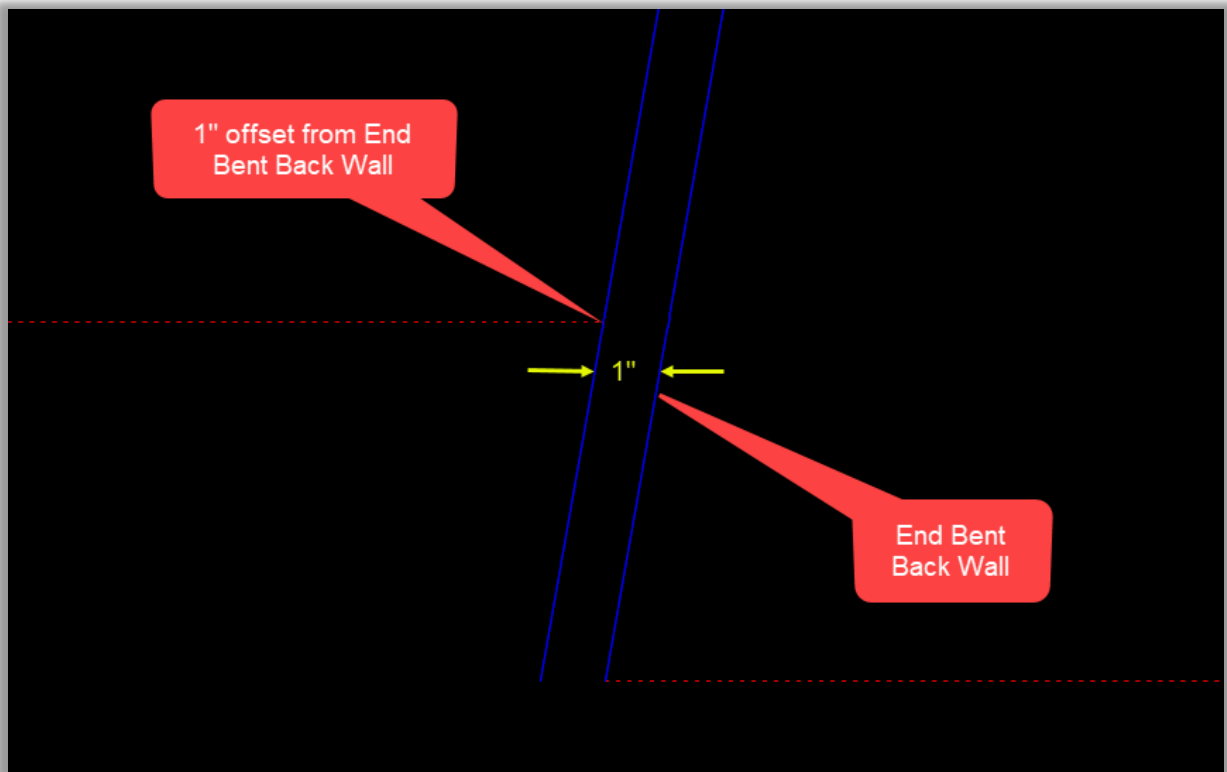
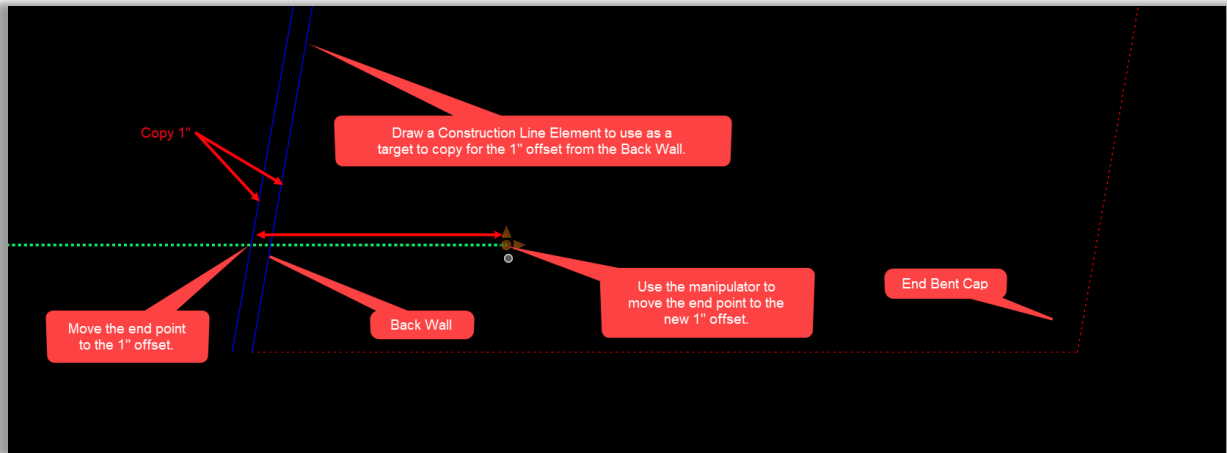
a. Confirm the Civil Rule Features for all 5 Vertical Geometry Active Profile Elements.



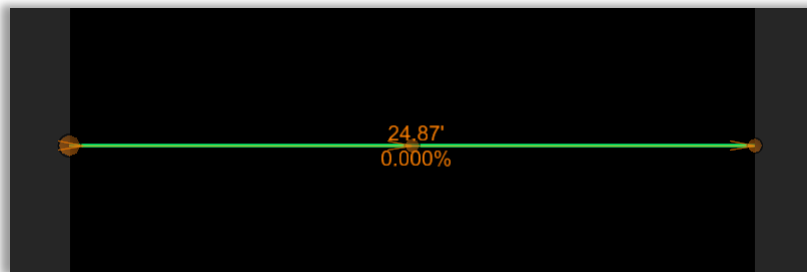
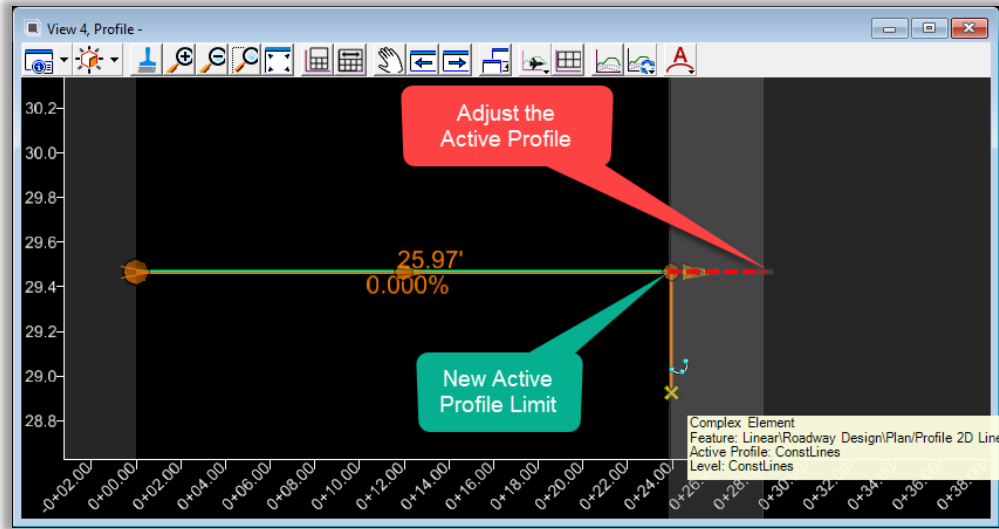
Note The horizontal and vertical geometry is no longer associated with the bridge model. Changes to the end bent cap and approach slab will not be automatically propagate to the wall geometry.

➤ **Modify the Horizontal and Vertical Geometry Targets for Linear Templates:**

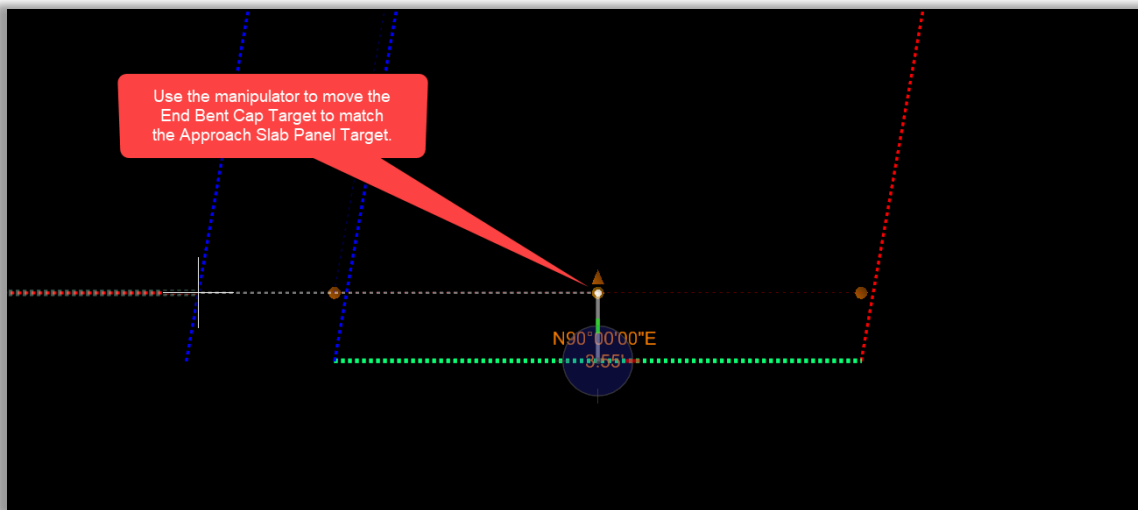
1. Adjust Horizontal & Vertical Geometry for accurate MSE Wall placement and create new targets for additional features. Note that your specific project data will dictate the exact dimensions and geometry needed to complete the modeling.
2. Adjust the Horizontal Approach Slab Panel Target to end 1" behind the End Bent Cap Backwall to account for expansion material.



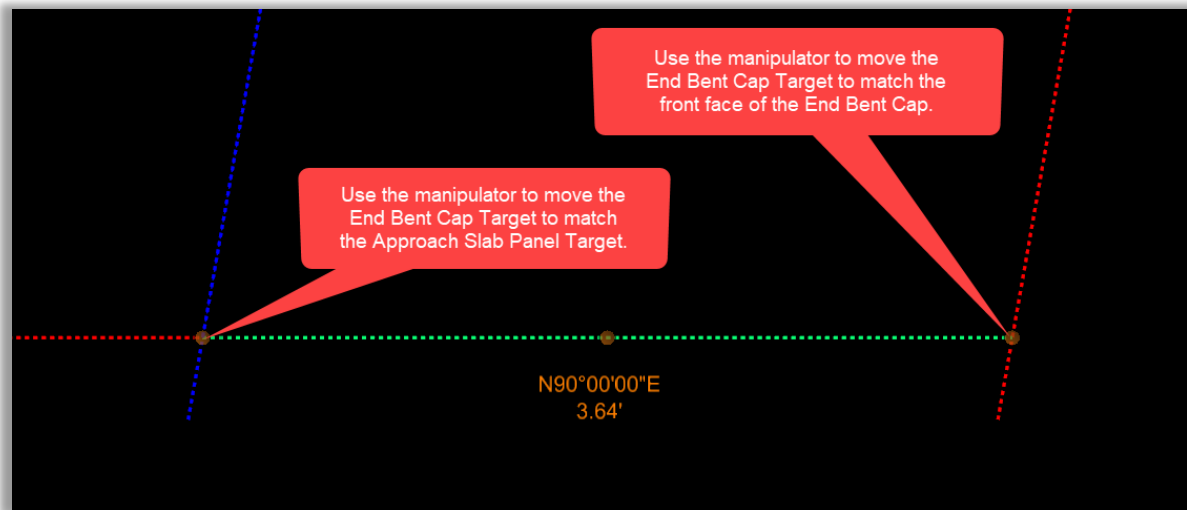
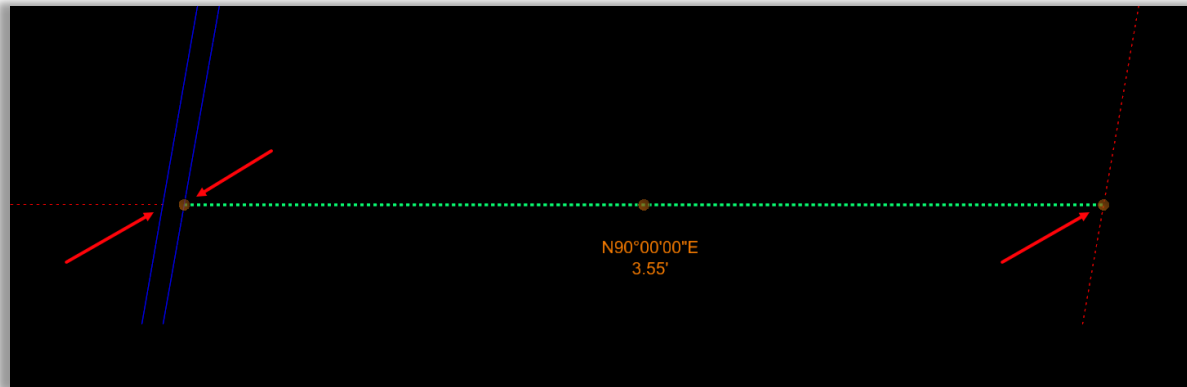
3. Adjust the Vertical Profile for the new length.



4. Repeat the Horizontal Approach Slab Panel Target adjustment and Vertical Profile length adjustment in Steps 2 and 3 for the other side of the Approach Slab.
5. Modify the Horizontal End Bent Cap Target to match the Approach Slab Target offset (0.46'). This represents the assumed width of the MSE wall panel, without the 1/2" expansion material.

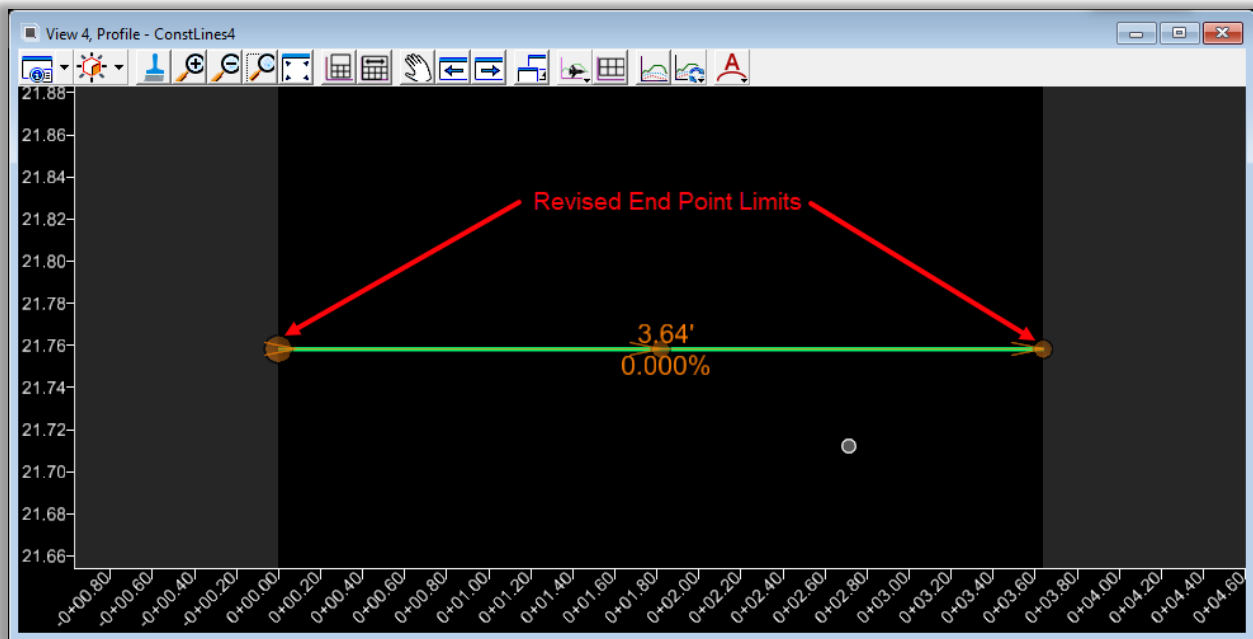
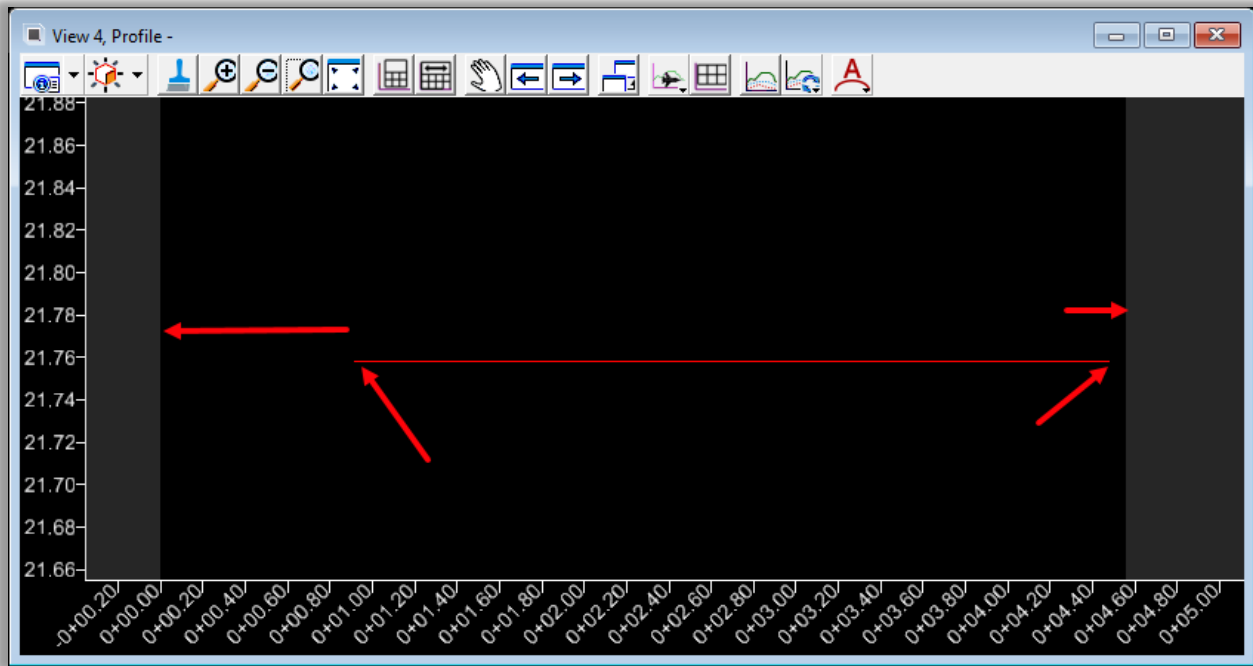


6. Repeat Step 5 for the Horizontal End Bent Cap Target on other side of the End Bent Cap.
7. Extend the beginning of the Horizontal End Bent Cap Target to match the Approach Slab Target (1"). Then, extend the end of the Horizontal End Bent Cap Target to match the front face of the End Bent Cap. Note that this will true up the target to match the skew in this example. You will not need to adjust the front face of the End Bent Cap if there is no skew to the bridge.

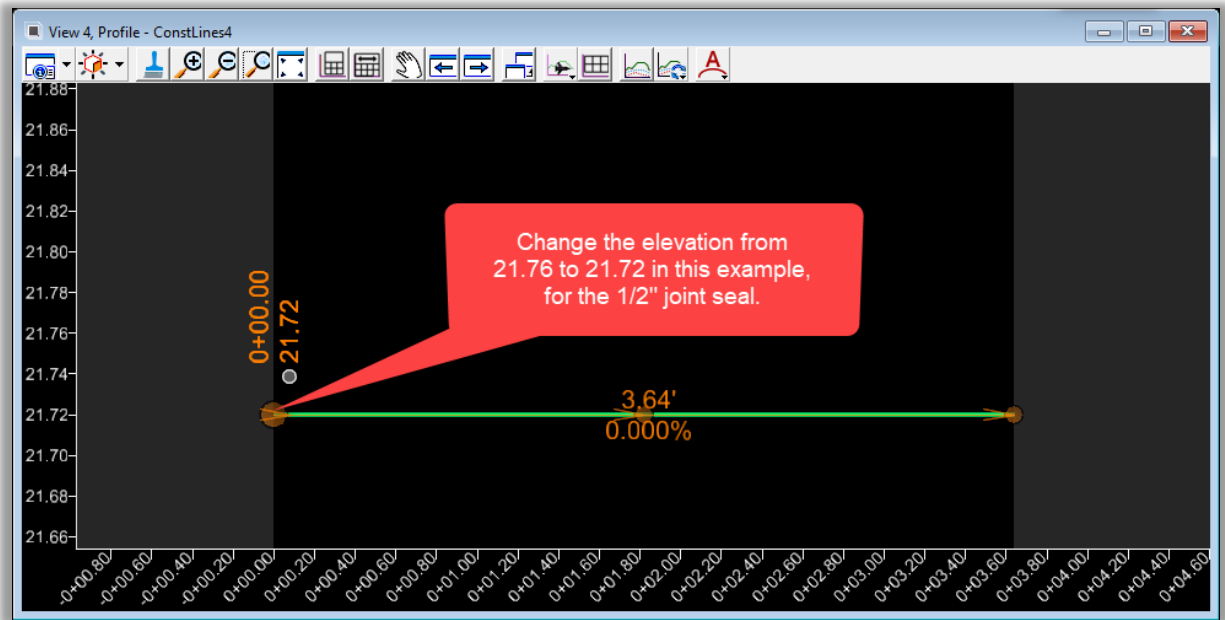


8. Repeat Step 7 for the Horizontal End Bent Cap Target on the other side of the End Bent Cap.

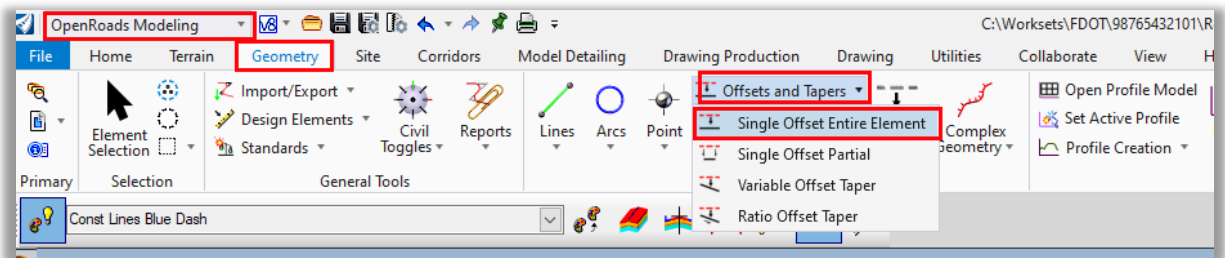
- Adjust the length of the End Bent Cap Target Profile to match the revised limits of the horizontal line.



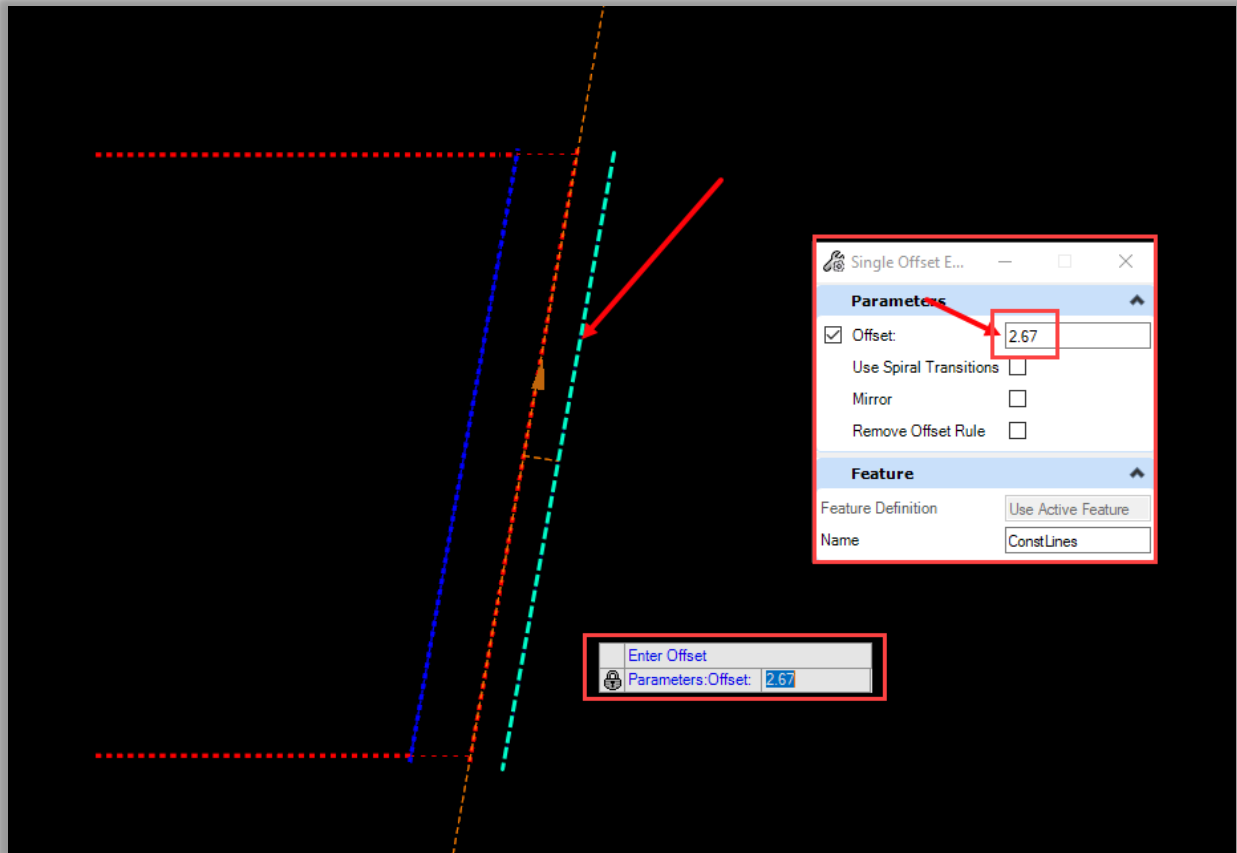
10. Lower the profile of the End Bent Cap Target by 1/2" to account for expansion material.



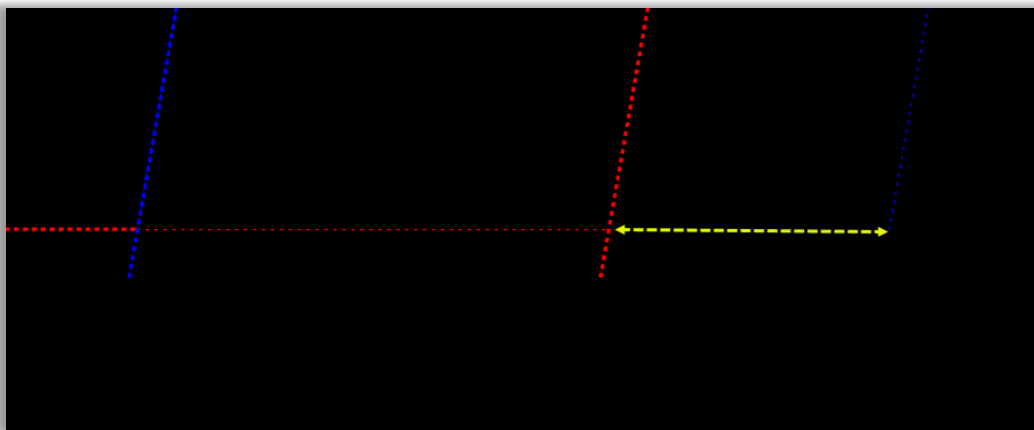
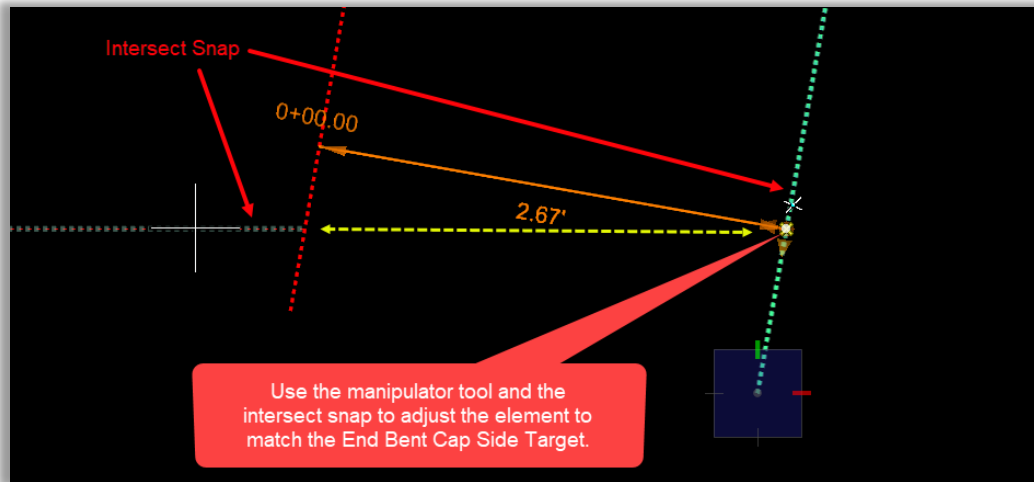
11. Repeat Steps 9 and 10 for the End Bent Cap Target Profile on the other side of the End Bent Cap.
12. Create a new Target element to represent the MSE Wall With Coping around the front side of the End Bent cap.



13. Single Offset Entire Element from the End Bent Cap 2.67' to represent the front face of the MSE Wall offset from the End Bent Cap. Offset will vary depending on project and must maintain minimum clear as required by the FDOT Structures Design Guidelines.



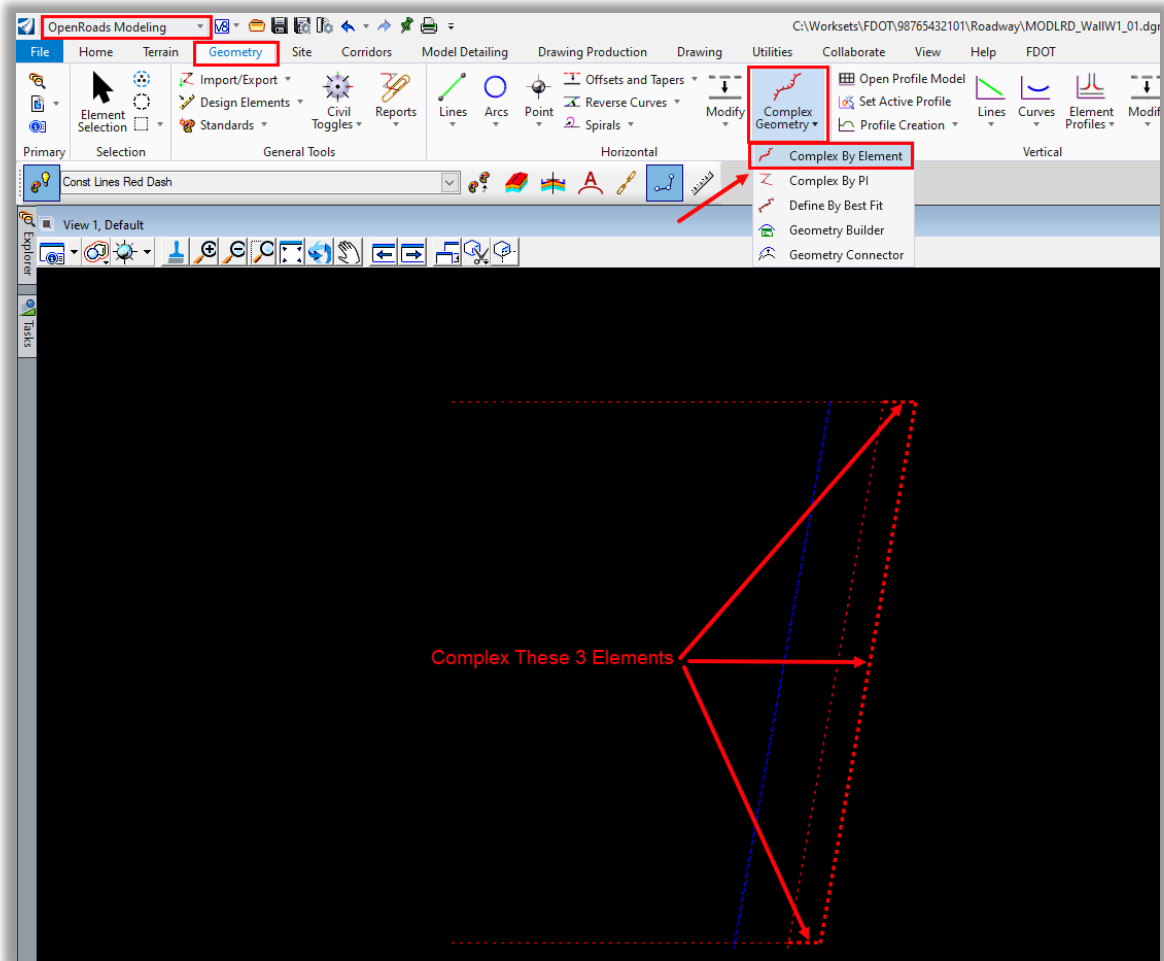
- Adjust the Begin & End limits of the newly created 2.67' offset element to match the End Bent Cap Side Target on both sides of the End Bent Cap.



- Create a Target Line to begin 0.04' from the Outside Front of the End Bent Cap to account for a 1/2" gap for expansion material. This element will provide the extra width needed in front of the End Bent Cap for the concrete slope pavement from the MSE Wall.

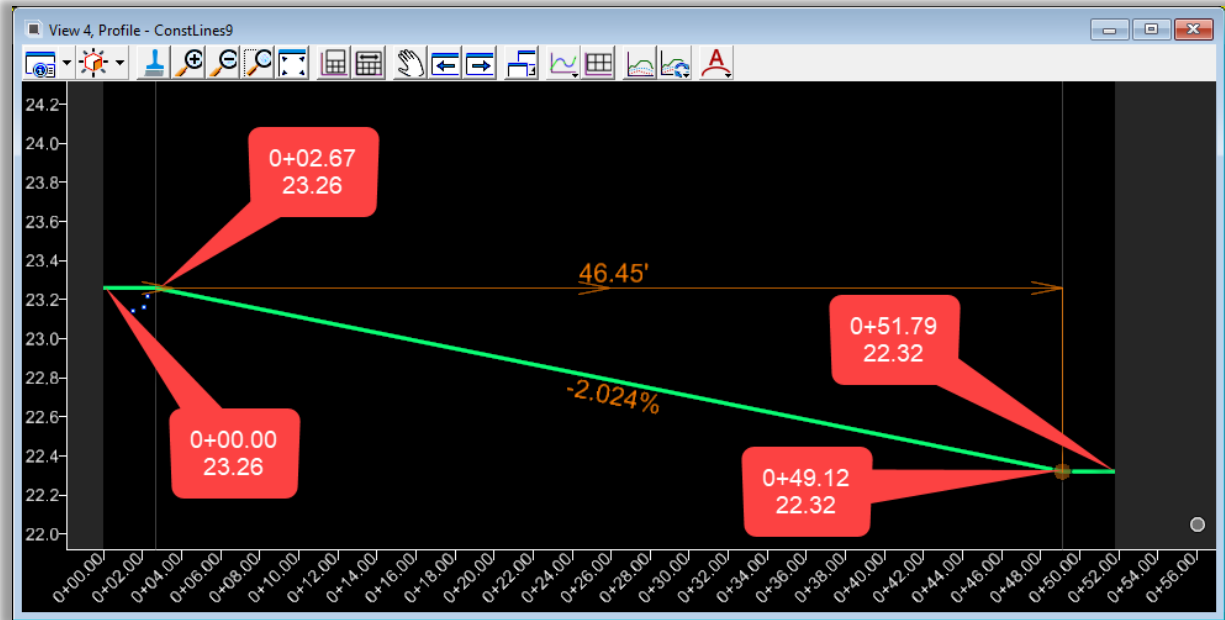


16. Repeat Step 15 for the other side of the End Bent Cap.
17. Complex these 3 New elements.

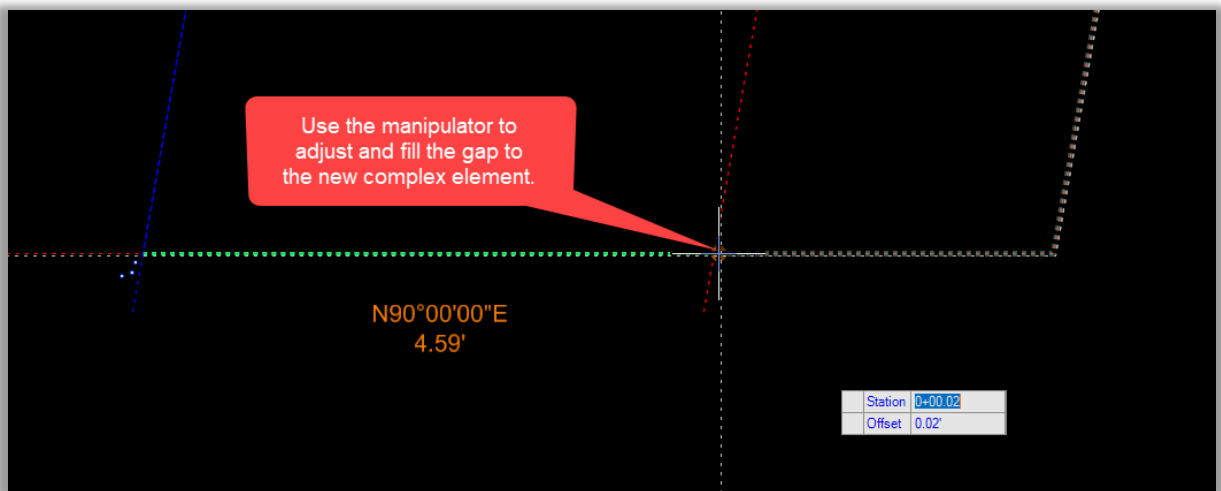


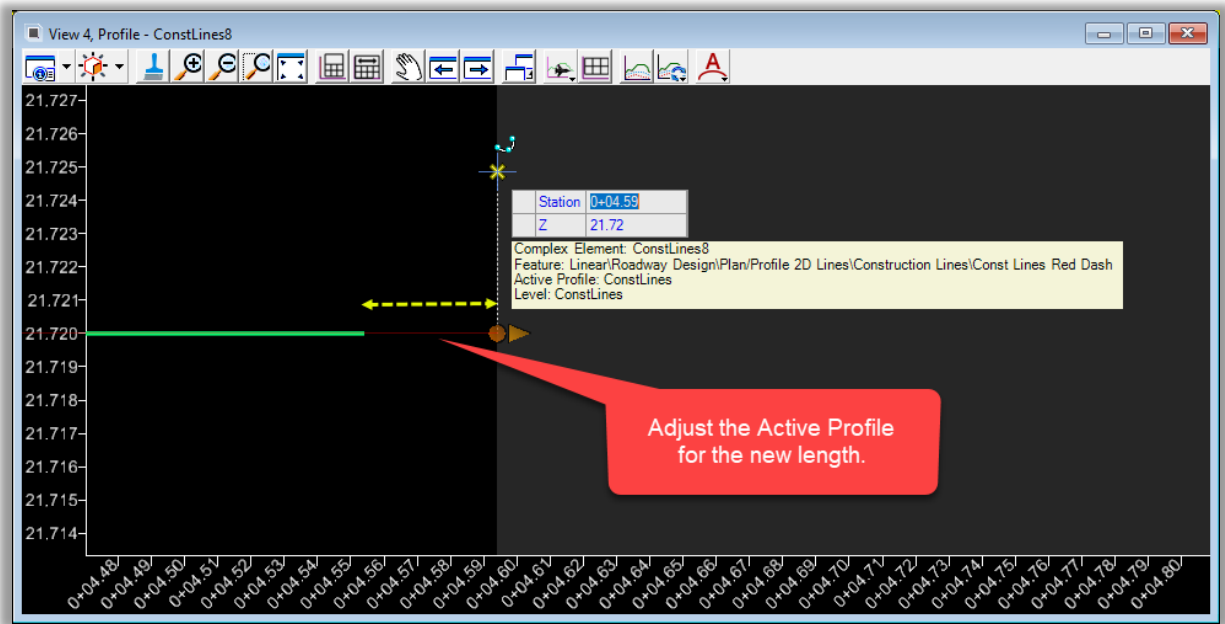
18. Create a new profile for the complex element that is a minimum of 1.5' above the bottom of the End Bent. For this example, the elevations were set based on the image below.

19. Set the profile as active.

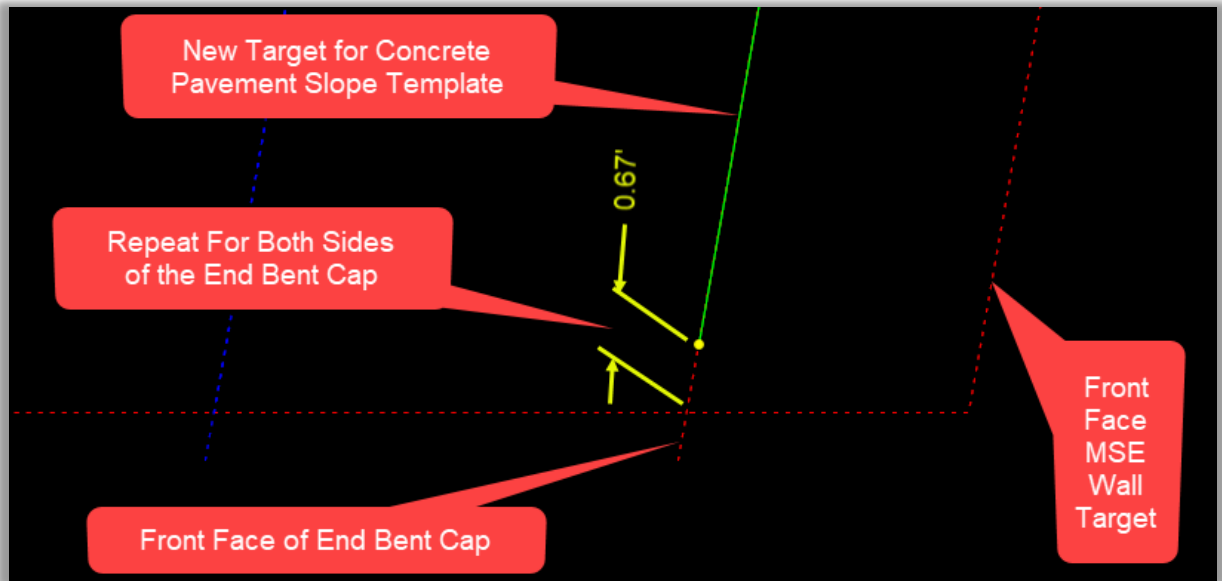


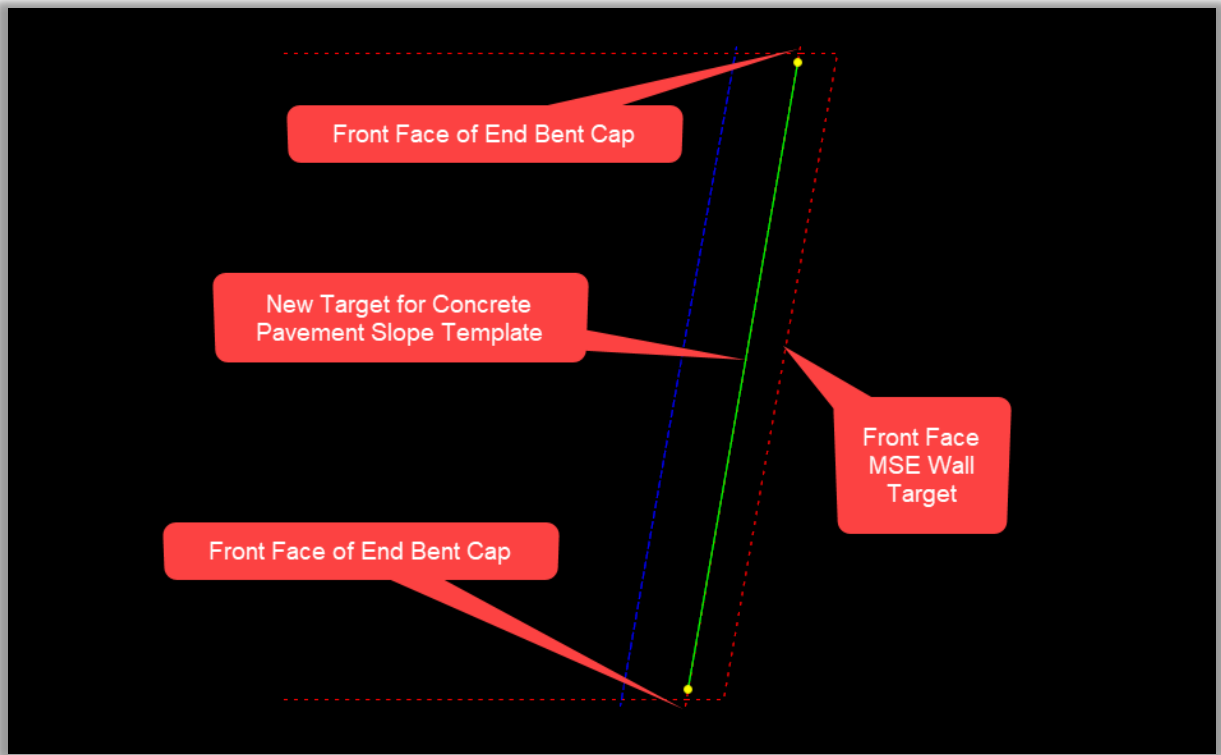
- 20. Extend the length of the Horizontal End Bent Cap Outside Target to match the new complex element.
- 21. Adjust the Active Profile for the new length.
- 22. Repeat Steps 21 and 22 for the Horizontal End Bent Cap Outside Target on the other side of the End Bent Cap.



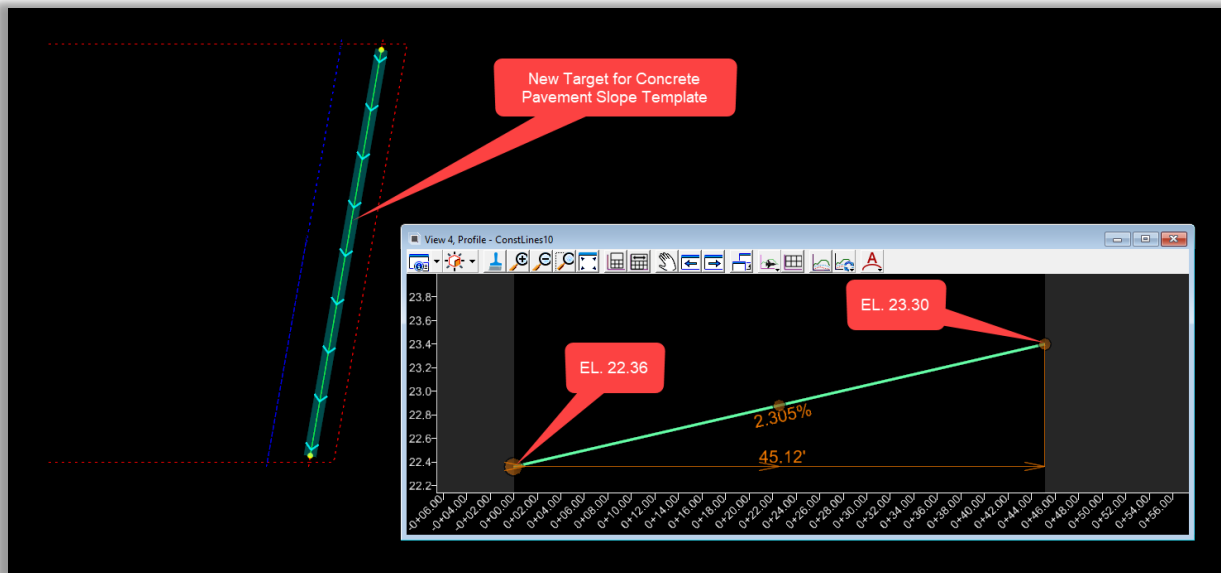


23. Create a Target for use with the Concrete Pavement Slope Template. Use the Front Face of the End Bent Cap element for reference.



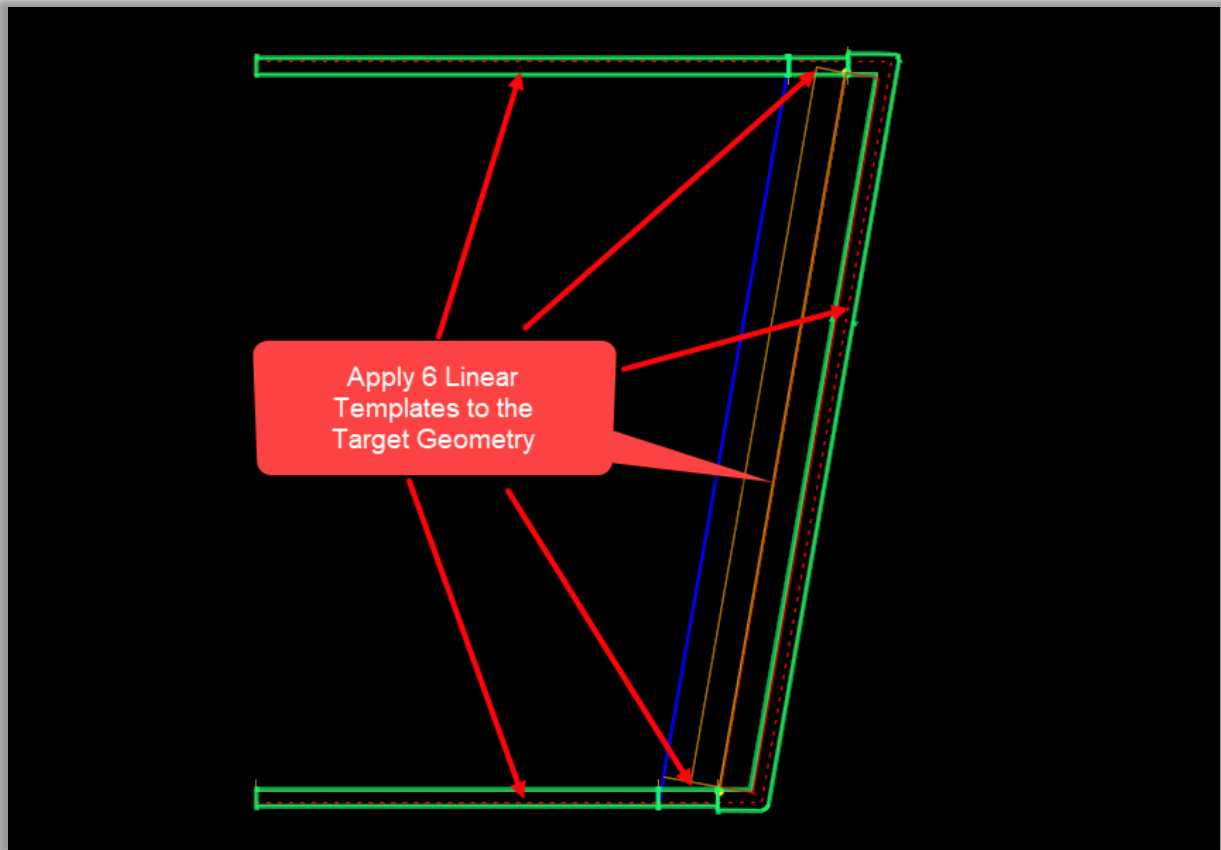


- 24. Create a new profile for the Concrete Pavement Slope Template Target. For this example, the elevations were set based on the image below. Set the profile as active.

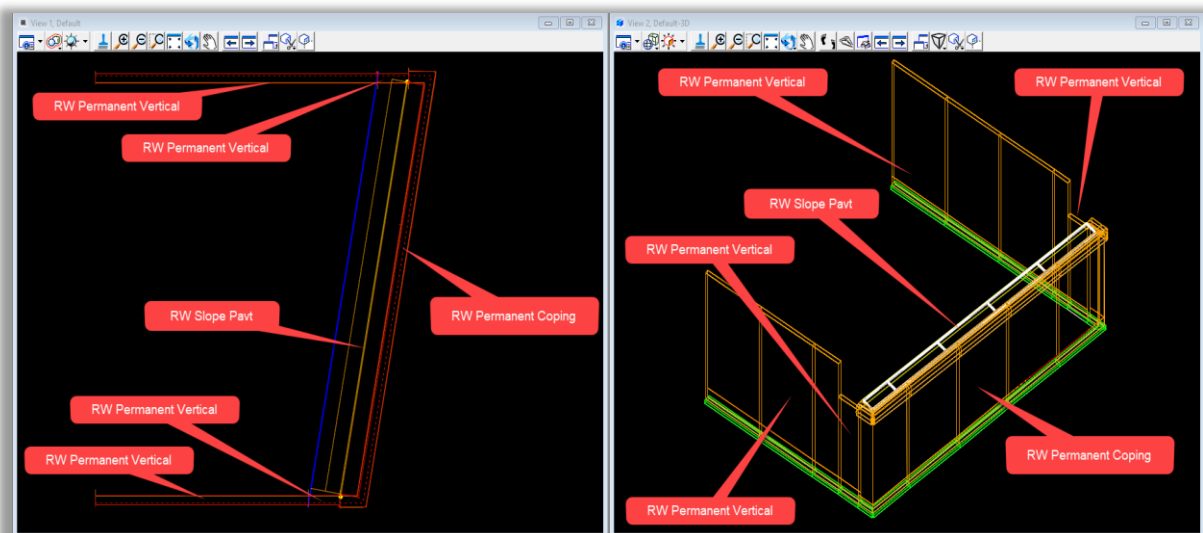


➤ **Place All Linear Templates to Model MSE Walls:**

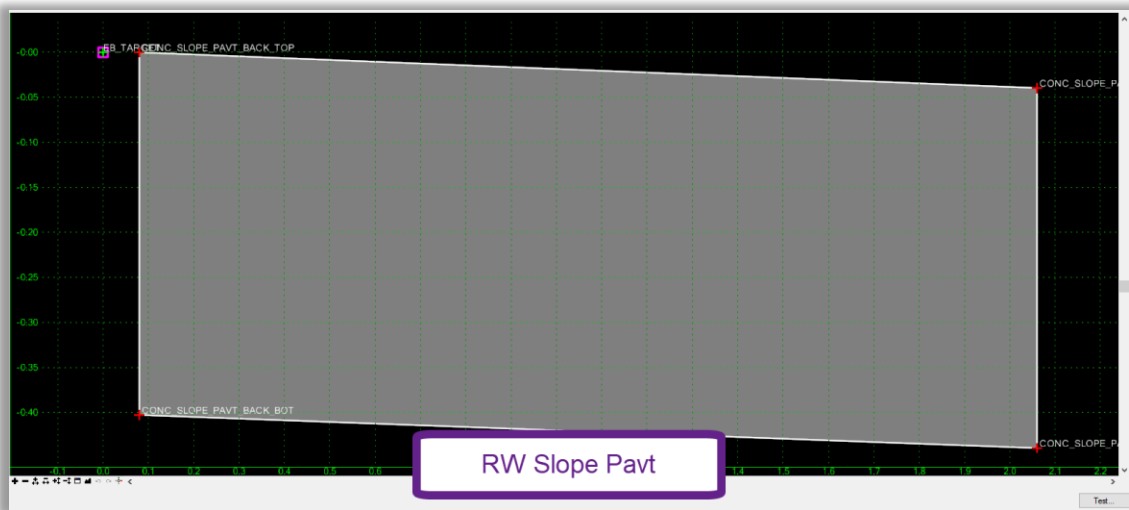
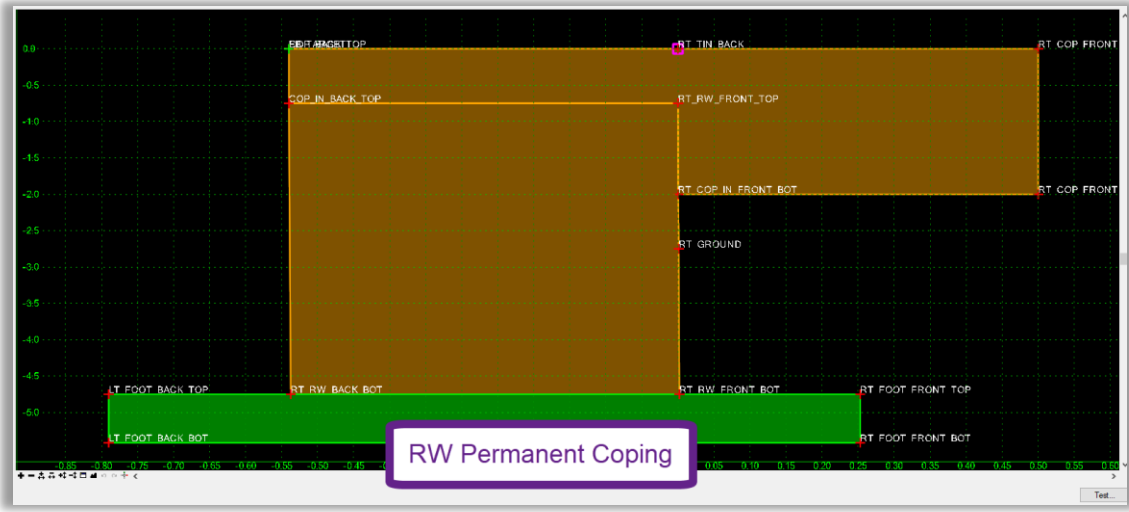
1. Apply the Linear Templates to the Target Elements.



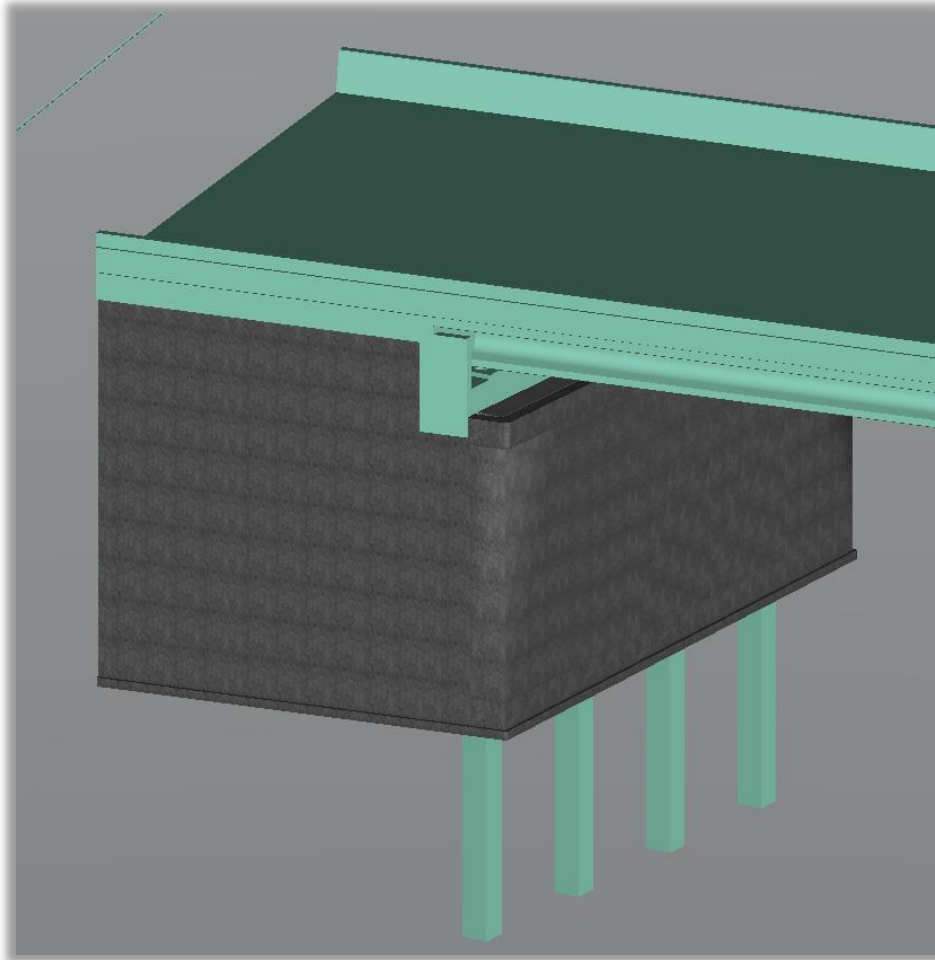
2. 6 Total Linear Templates & Template Names should be applied as shown below.

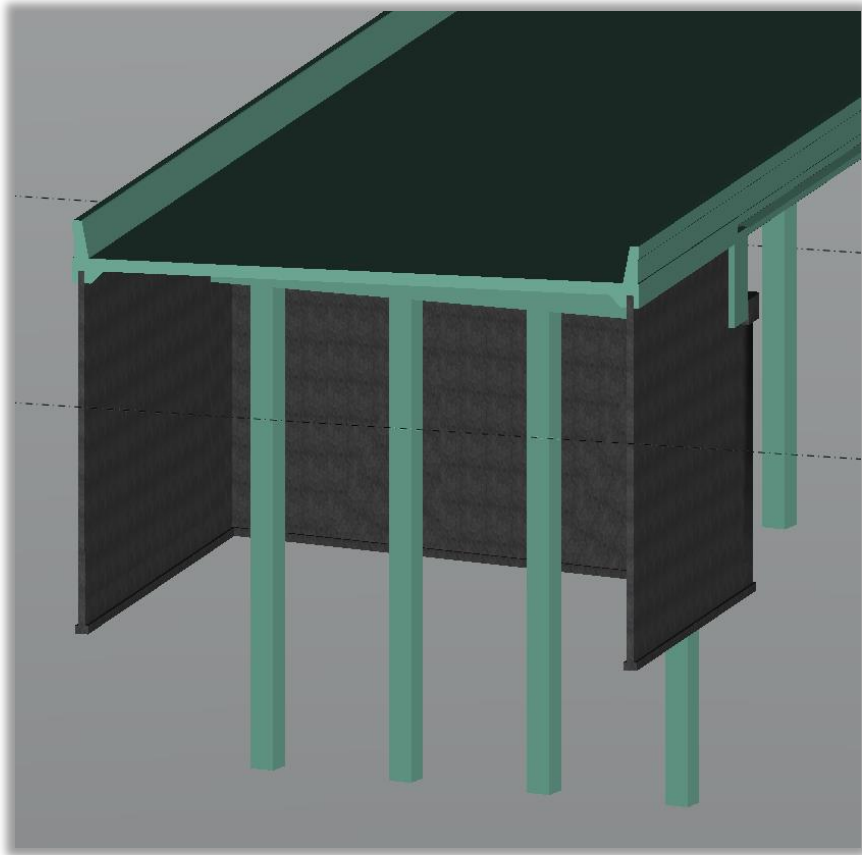
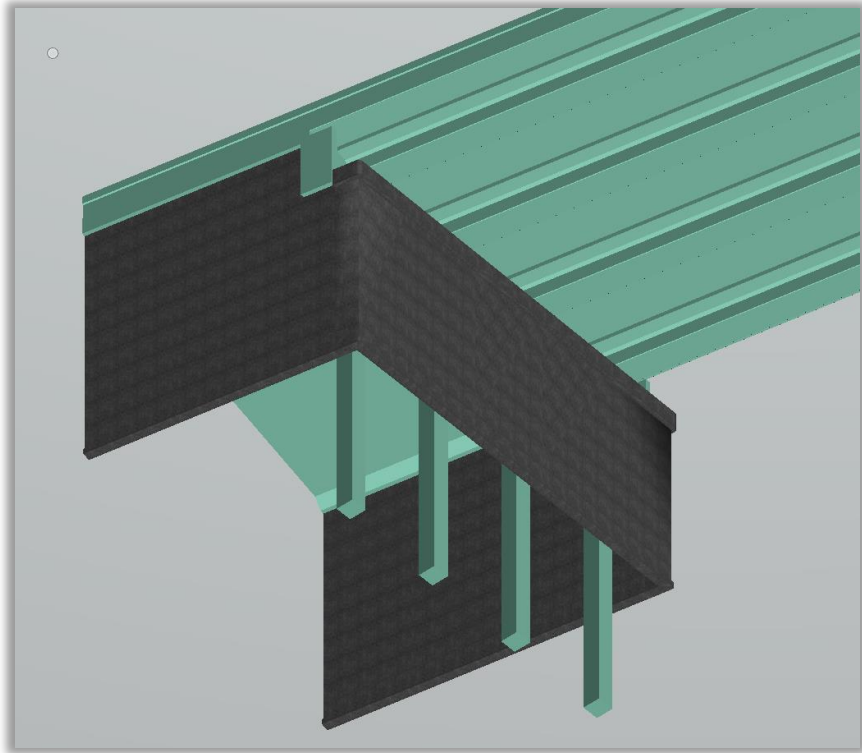


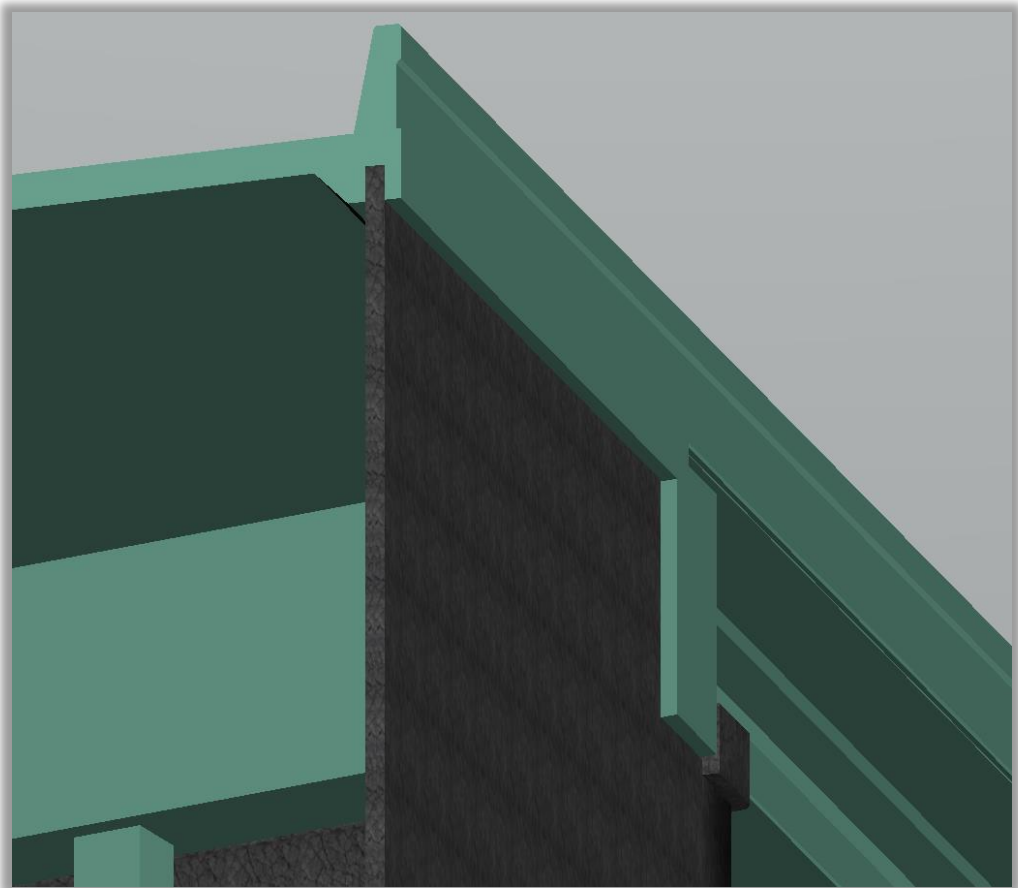
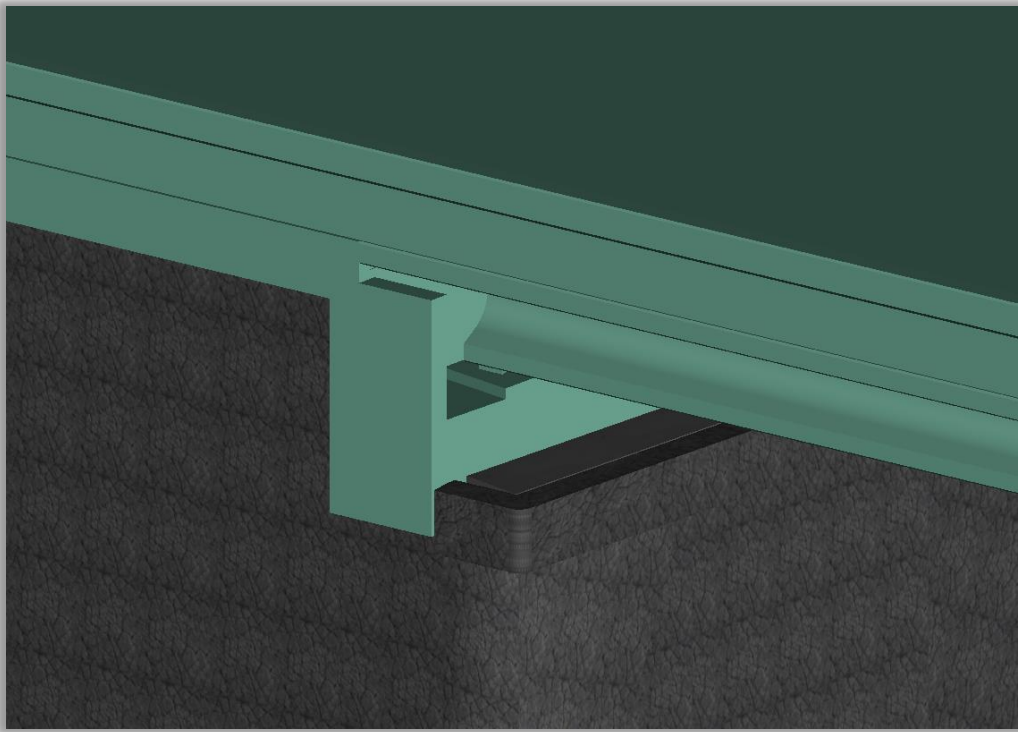
Each of the 3 Templates Used:



Final Views with OBM Reference (Note: The end bent “lug” is not shown.):



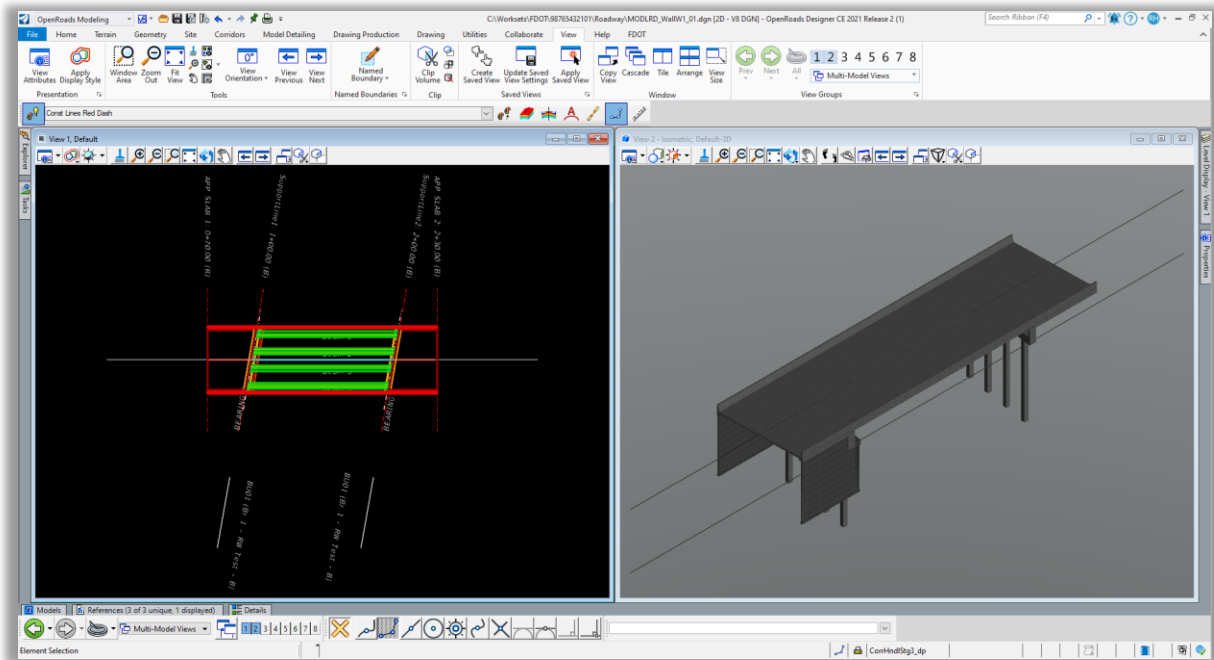




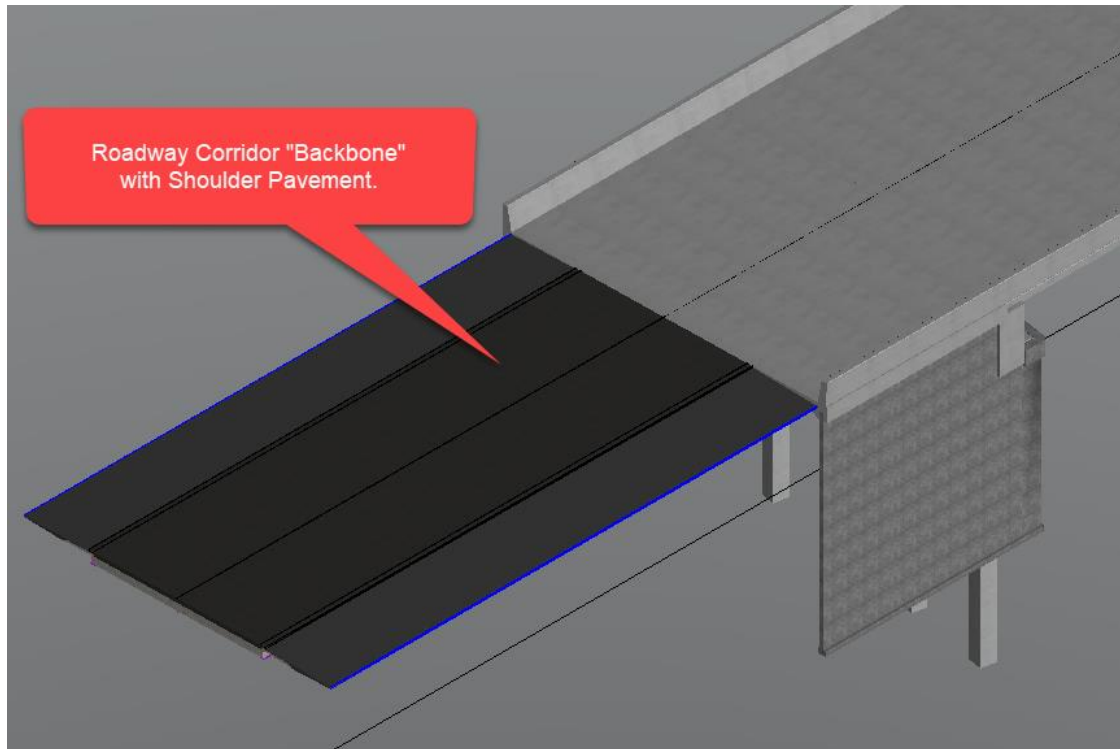
Exercise 1.2 Create a Roadway MSE Wall for the Roadway Backbone Corridor

➤ Apply Wall Template along Roadway Corridor:

1. Continue in the file **MODLRD_WallW1_01.dgn**, created in Exercise 1.1.

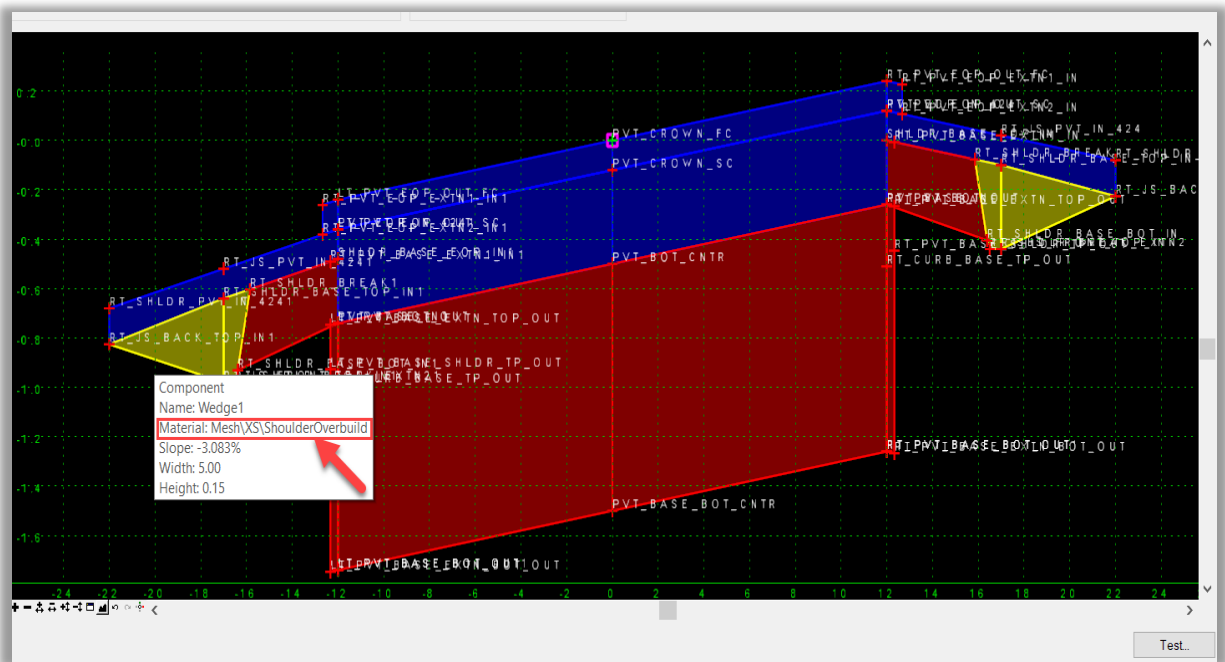


2. For this exercise, we will apply an MSE Retaining Wall Template to a Roadway Corridor “Backbone” as a reference for the MSE Retaining Wall modeling.



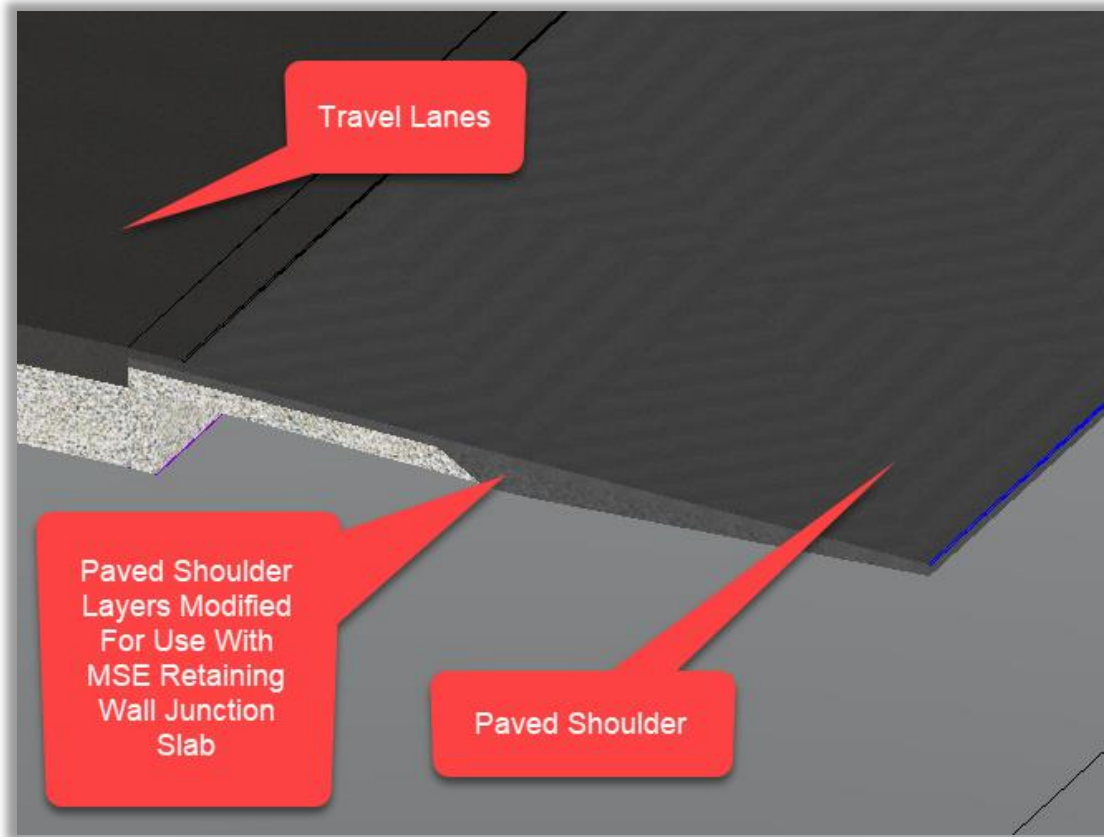
This training example assumes that a Roadway Corridor “Backbone” with Shoulder Pavement has already been created and will use a Roadway Corridor as a reference for the Roadway MSE Retaining Wall modeling.

The Roadway Corridor assumes 2 - 12’ travel lanes at 2.00% with 10’ Paved Shoulders to match the OBM model width used in Exercise 1.1. Example Roadway Corridor “Backbone” with Shoulder Pavement Template shown below.

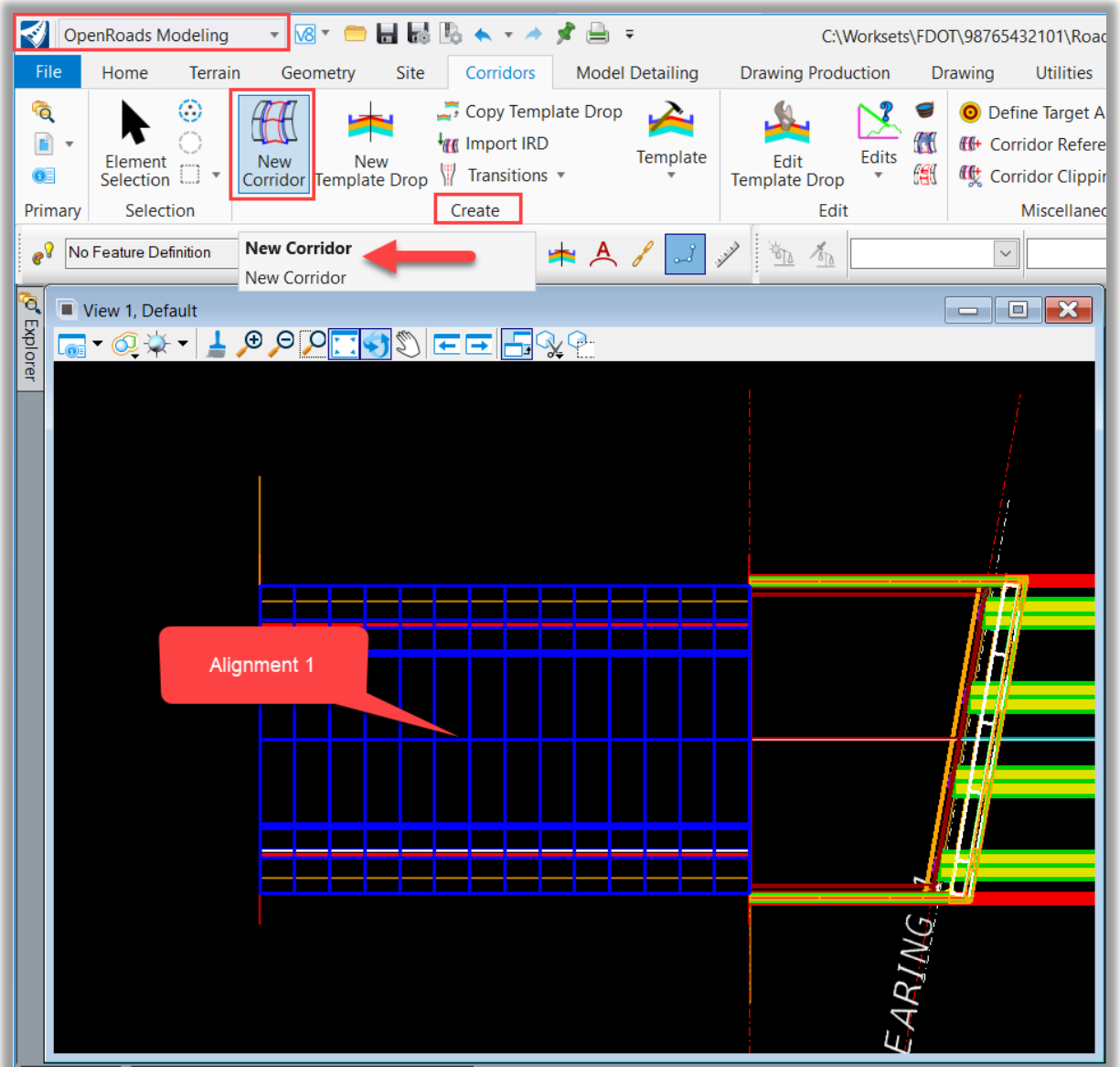


Note The Roadway Shoulder modified through the Proposed Wall limits for MSE Wall with a Junction Slab is included in this example, as several of the Roadway Shoulder Components are integral to the MSE Retaining Wall placement and accurate modeling. The Roadway Shoulder Pavement Layers & Cross Slopes, including the small wedge of Overbuild atop the Junction Slab to match the Standard Plans details, are taken into consideration. See FDOT Standard Plans 521-610 for more details.

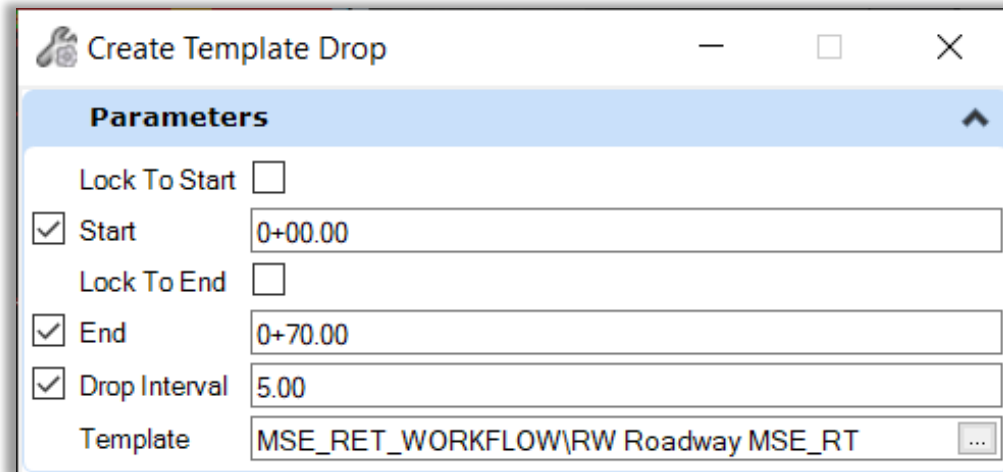
Example Roadway Corridor “Backbone” with Modified Shoulder Pavement Components for MSE Retaining Wall Junction Slab Completed 3D View:



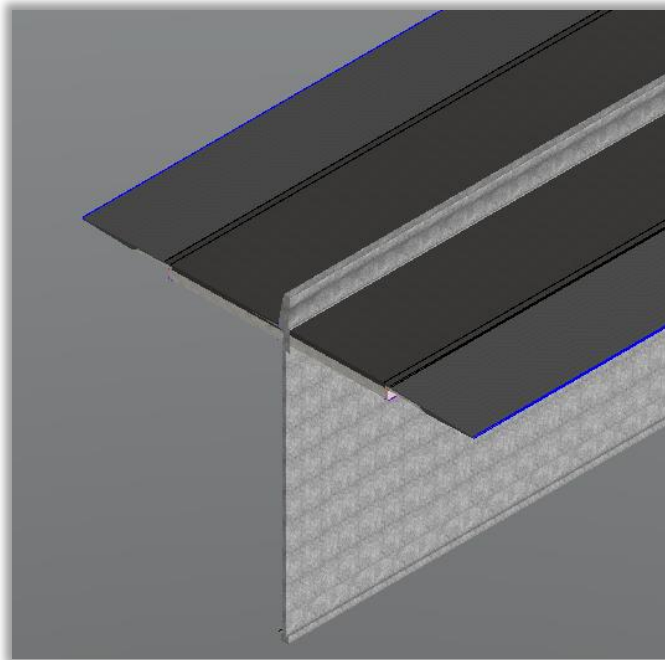
3. To add the Roadway MSE Retaining Wall to the Example Roadway Corridor “Backbone” with Shoulder Pavement, we need to create a new corridor RT_RET_WALL_1 along “Alignment 1.” Note that another alternative is to create a separate Alignment that will represent the MSE Retaining Wall and apply the new corridor to that alignment.



4. Apply a Template Drop for the new corridor Right MSE Retaining Wall.

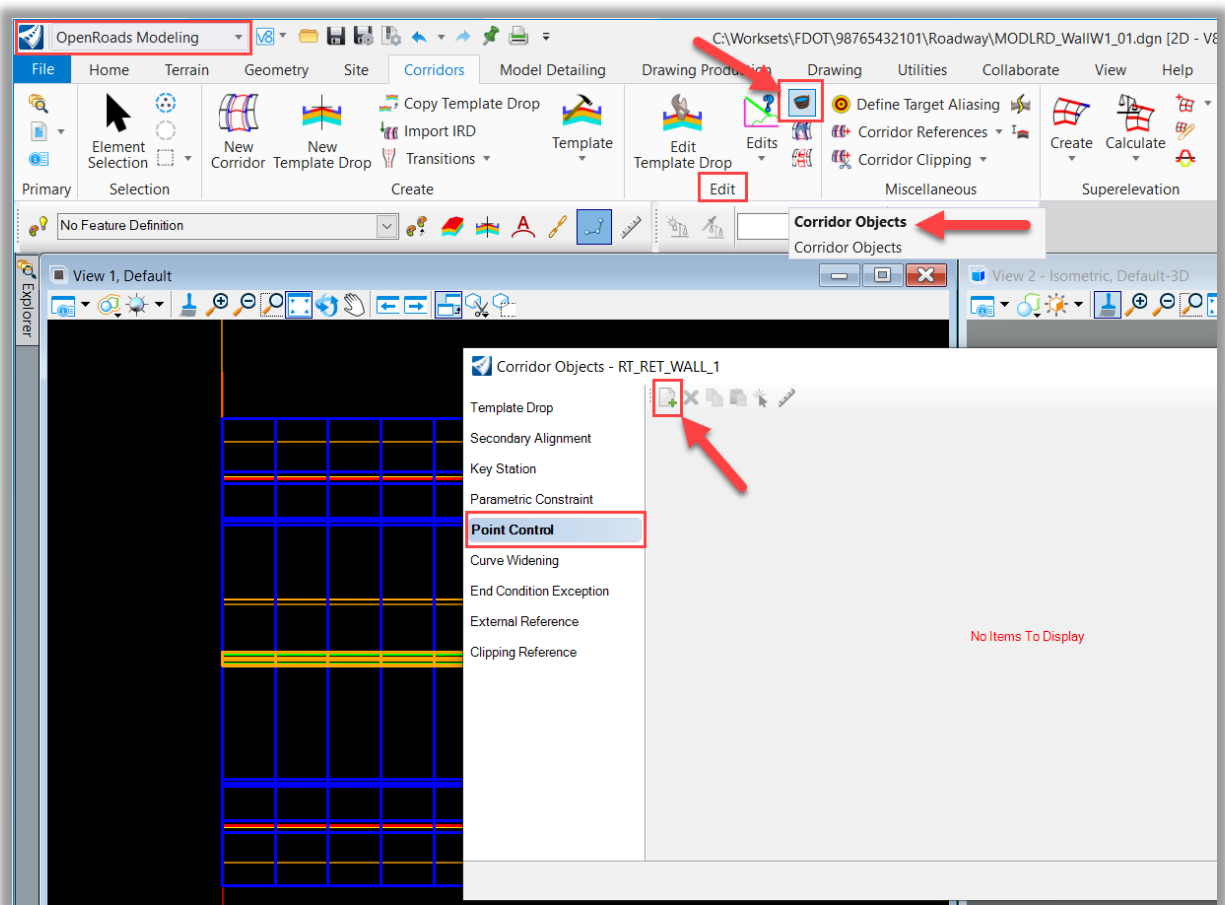


Note that the RT MSE Retaining Wall Template Drop will appear in the middle of the Alignment 1 Corridor. We will apply a point control to align the RT MSE Retaining Wall with the Outside of the Right Paved Shoulder.



5. Create a Point Control for the Corridor RT_RET_WALL_1, that will allow it to follow the outside edge of the Right Paved Shoulder both horizontally and vertically.

6. Open the Corridor Objects Tool, **OpenRoads Modeling > Corridors > Edit > Corridor Objects**. Follow the prompt to select the Corridor RT_RET_WALL_1.



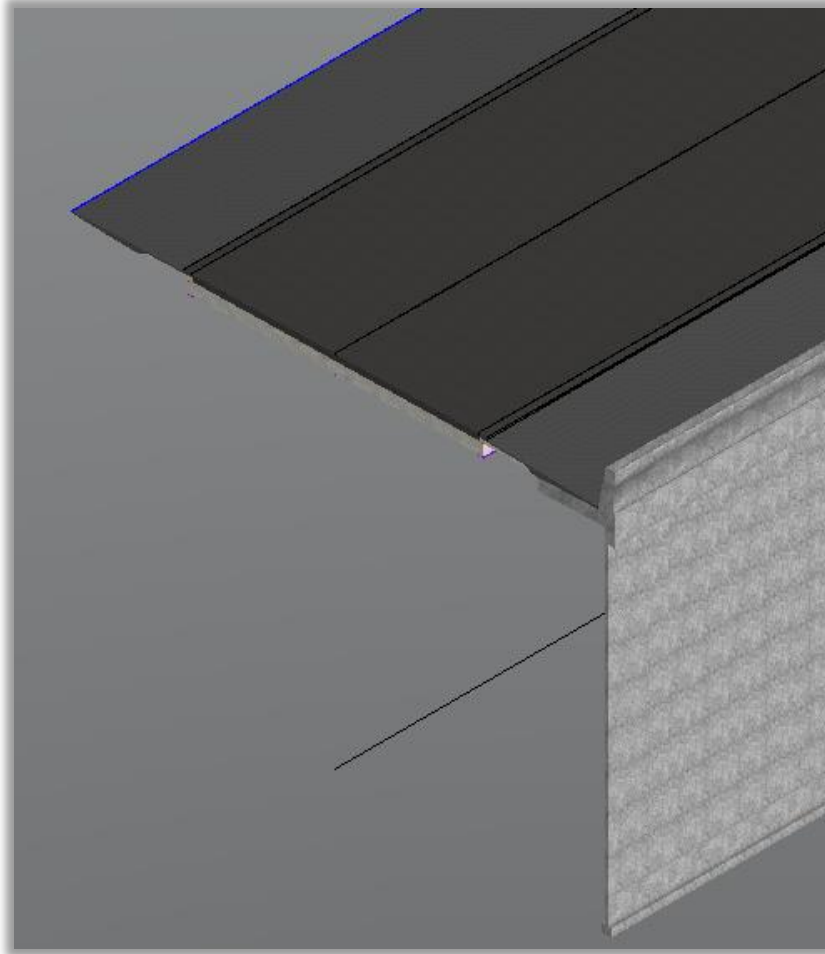
7. Configure the Point Control:

Parameters	
Lock To Start	<input type="checkbox"/>
<input checked="" type="checkbox"/> Start	0+00.00
Lock To End	<input type="checkbox"/>
<input checked="" type="checkbox"/> Stop	0+70.00
Control Description	RT MSE RET WALL
Point	RT_SHLDR_PVT_IN
Mode	Both
Control Type	Corridor Feature
Corridor	Alignment1
Reference Feature	RT_SHLDR_PVT_TOP_O
Priority	1

Horizontal Offsets	
Start	0.00
Stop	0.00

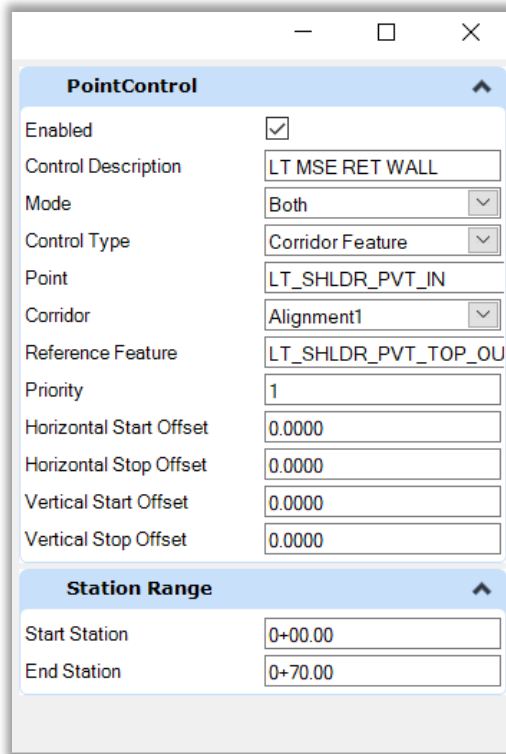
Vertical Offsets	
Start	0.00
Stop	0.00

8. The Template Drop will adjust to connect to the outside edge of the Right Paved Shoulder.



9. Repeat for the Left side of the Roadway Corridor "Backbone" with Shoulder Pavement.

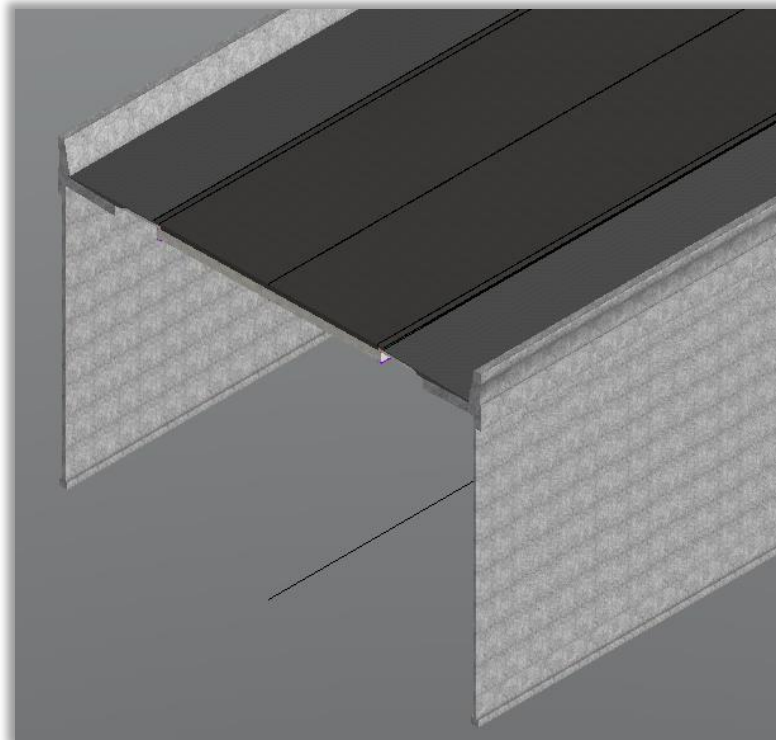
10. Configure the Point Control:



PointControl	
Enabled	<input checked="" type="checkbox"/>
Control Description	LT MSE RET WALL
Mode	Both
Control Type	Corridor Feature
Point	LT_SHLDR_PVT_IN
Corridor	Alignment1
Reference Feature	LT_SHLDR_PVT_TOP_OU
Priority	1
Horizontal Start Offset	0.0000
Horizontal Stop Offset	0.0000
Vertical Start Offset	0.0000
Vertical Stop Offset	0.0000

Station Range	
Start Station	0+00.00
End Station	0+70.00

11. Review the completed 3D Model for the Left & Right MSE Retaining Walls:



Exercise 1.3 Create a Variable Depth MSE Wall Leveling Pad

➤ Import Leveling Pad Profile:

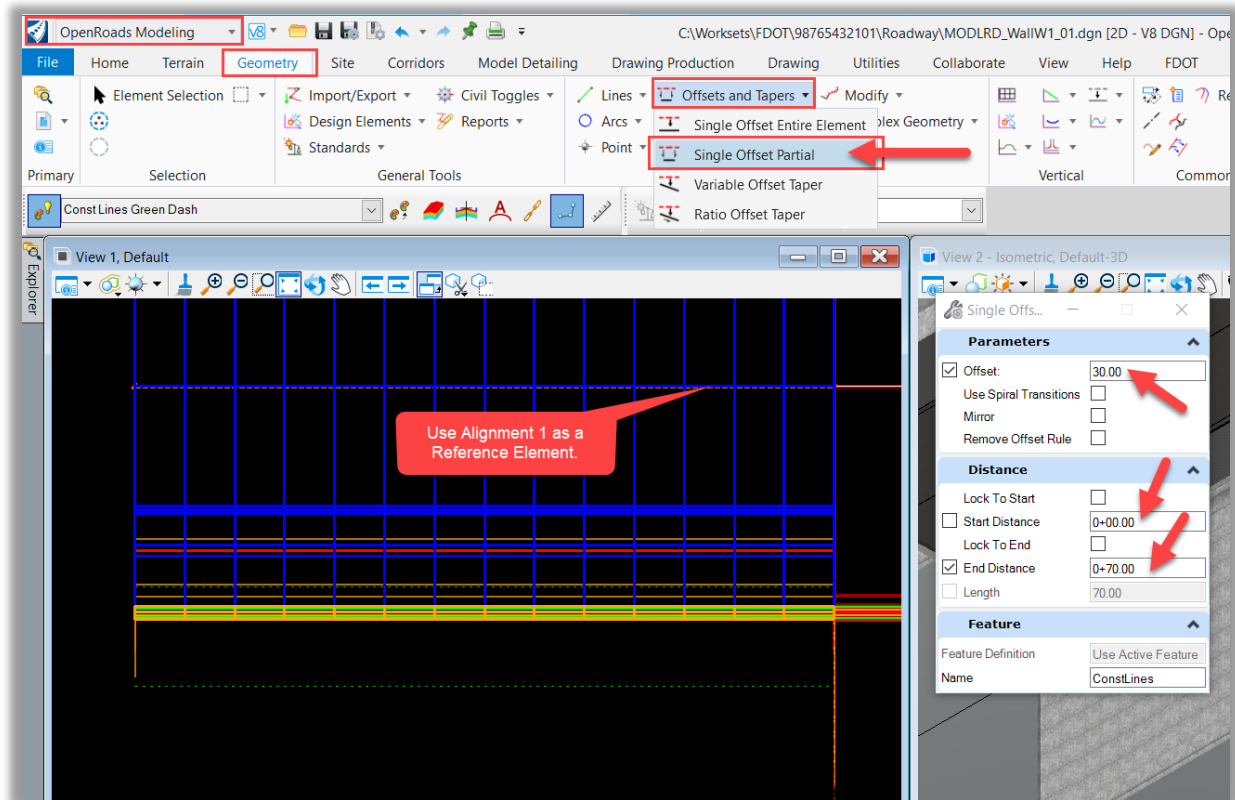
1. Continue in the file **MODLRD_WallW1_01.dgn**, created in Exercise 1.1 and as modified in Exercise 1.2.

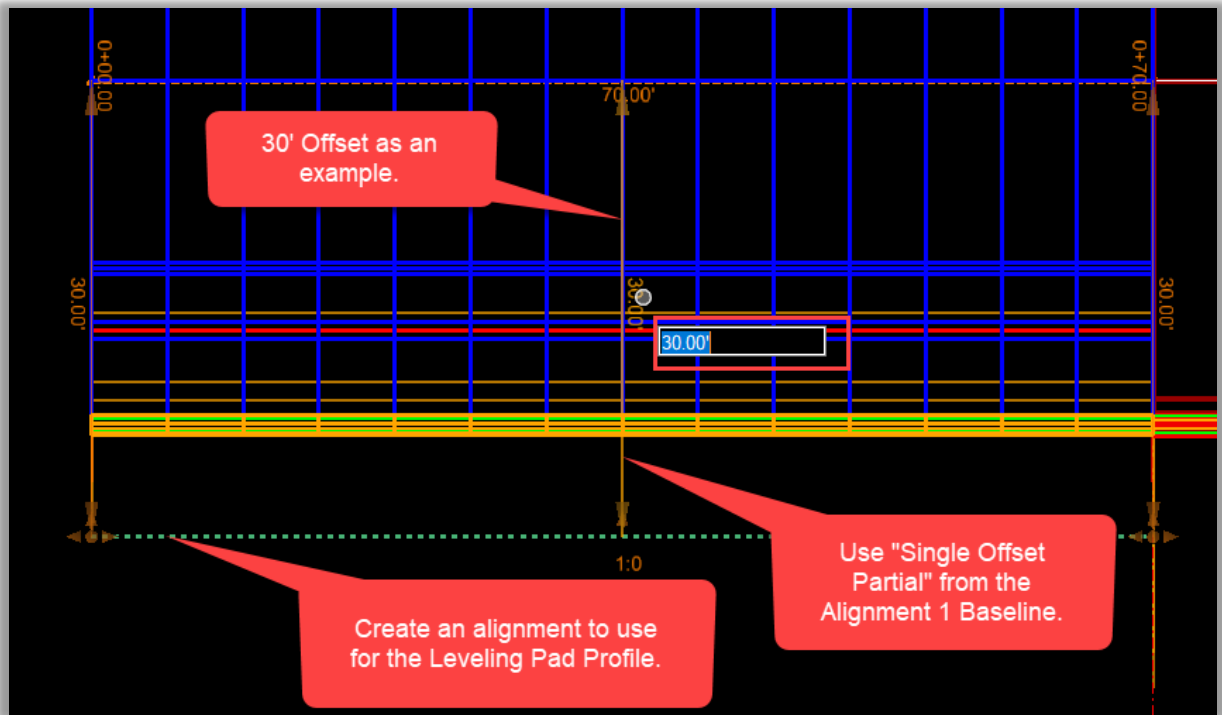
We will import a vertical geometry profile from an ASCII file that will control the top elevation of the leveling pad in the MSE Retaining Wall.

2. Use the Single Offset Partial tool to make a copy of the Alignment 1 Horizontal Geometry at a 30' Offset Right to create a Horizontal Geometry Alignment. This will be used as a base element to apply the Leveling Pad Profile.

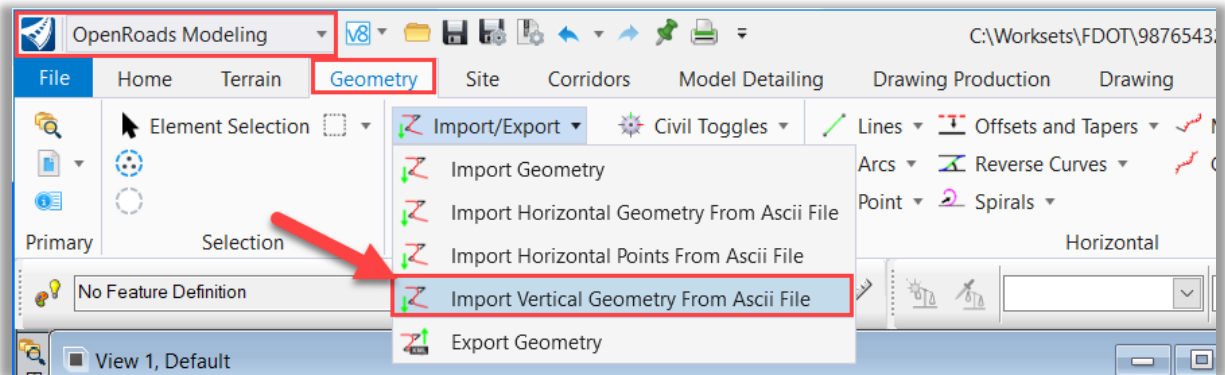
Note that this could also be used to place the MSE Retaining Wall Corridors that were created in the previous exercise. The actual offset value is not important, as this will just serve to apply Vertical Geometry Imported Profile.

3. Const. Lines Green Dash or similar can be used for the Feature Definition.



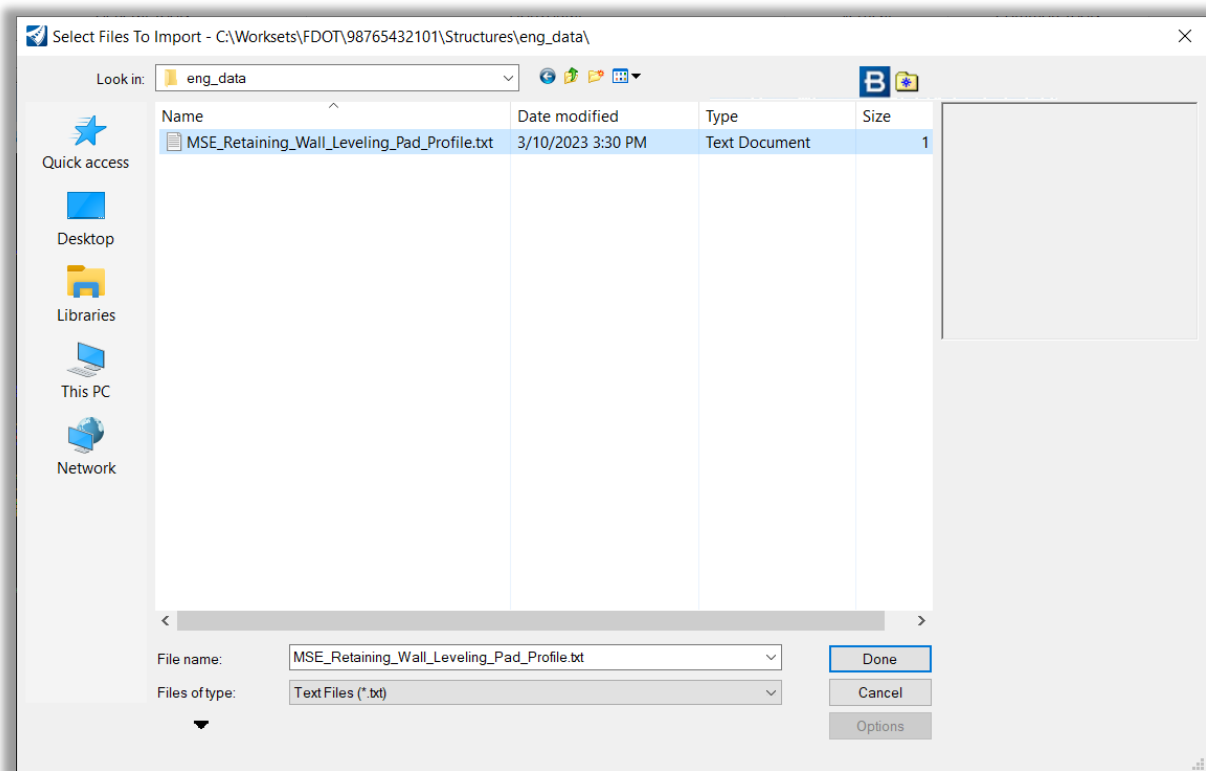
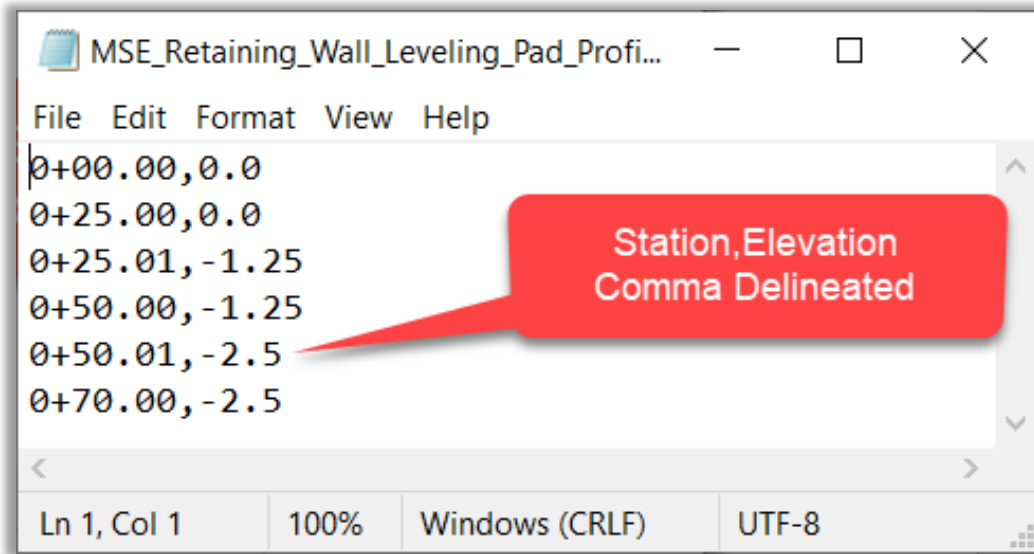


4. Import Vertical Geometry From Ascii File. **OpenRoads Modeling > Geometry > General Tools > Import/Export > Import Vertical Geometry From Ascii File.**



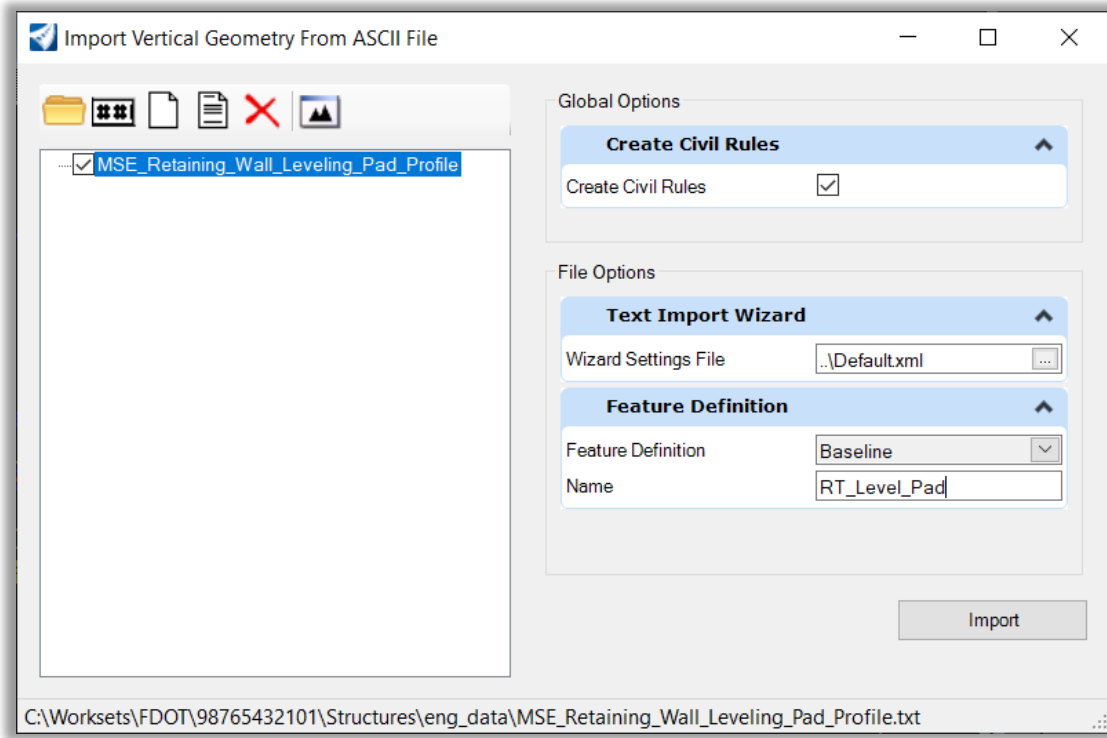
5. Follow the prompts to select the Plan View Element and choose the Green Dashed Geometry from the previous step.
6. Browse to your Text File containing the specific Profile information for your MSE Retaining Wall Leveling Pad Profile.

7. Example Ascii Text File containing the MSE Retaining Wall Leveling Pad Profile information:

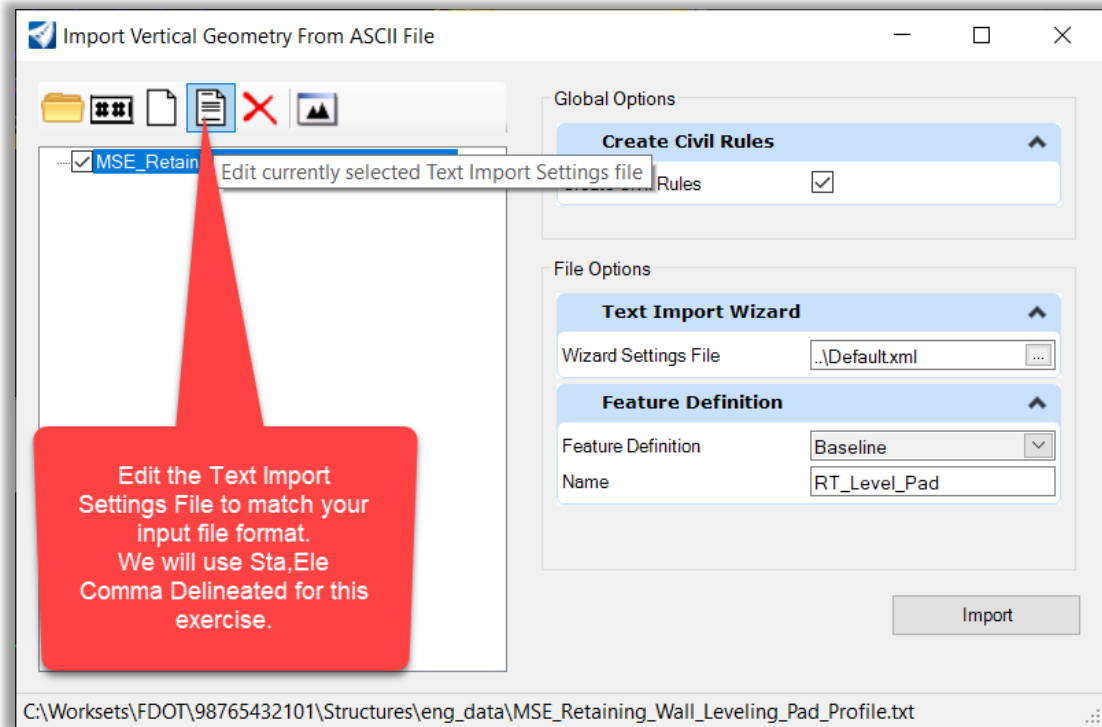


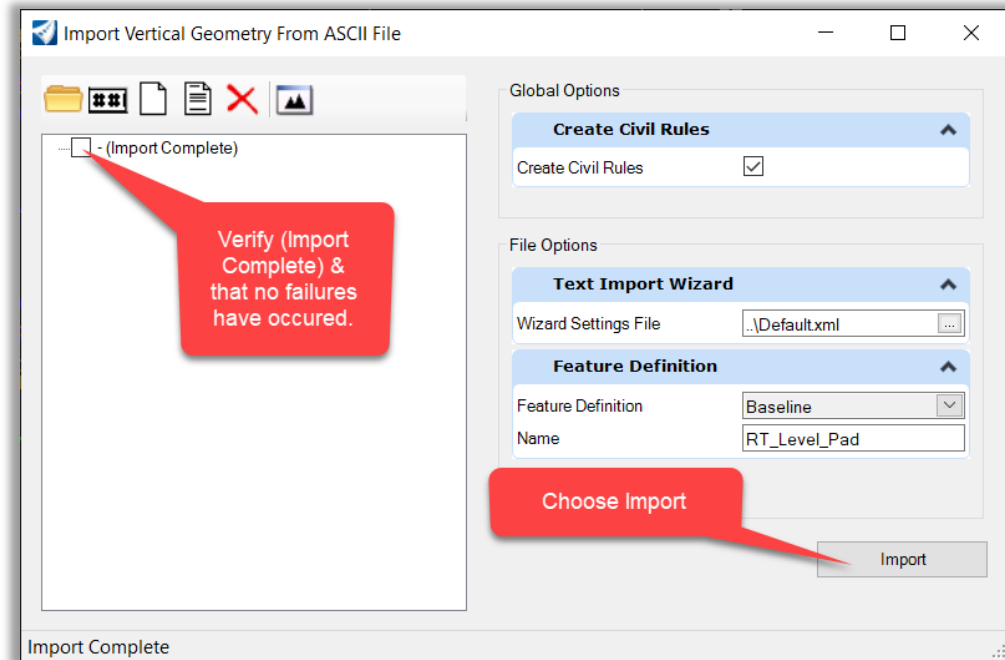
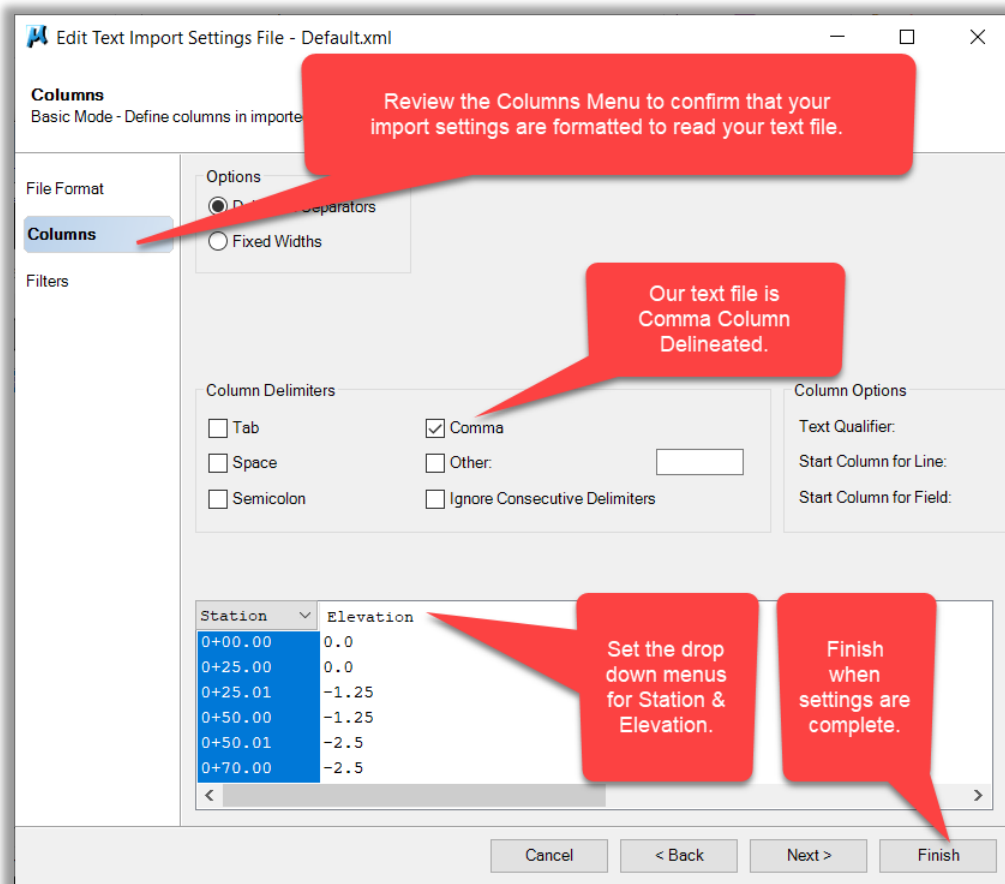
Note It is possible to design the Leveling Pad Profile using the Vertical Geometry Tools in ORD. For this workflow example, utilizing the ORD tool “Import Vertical Geometry From Ascii File” ORD is not capable of creating the geometry for a vertical line in a profile. Because this workflow utilizes the ASCII profile input text file as a target for the leveling pad elevation step vertical geometry, you’ll notice in the ASCII text file that the vertical stepping occurs over 0.01’ horizontally along the alignment.

8. Choose the applicable settings for your import format. See the following images for example settings.

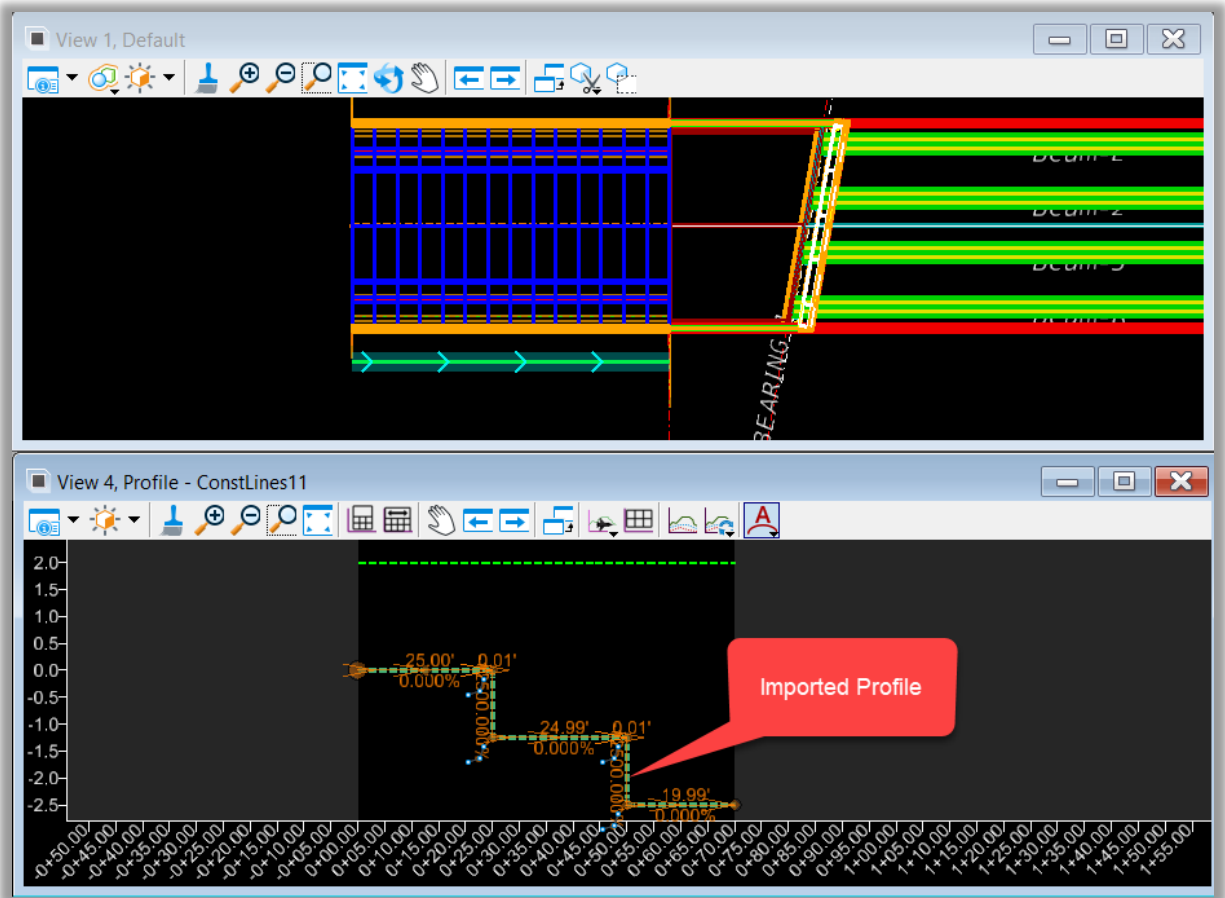


9. It is important that you verify or modify the Text Import Settings to read your profile data.



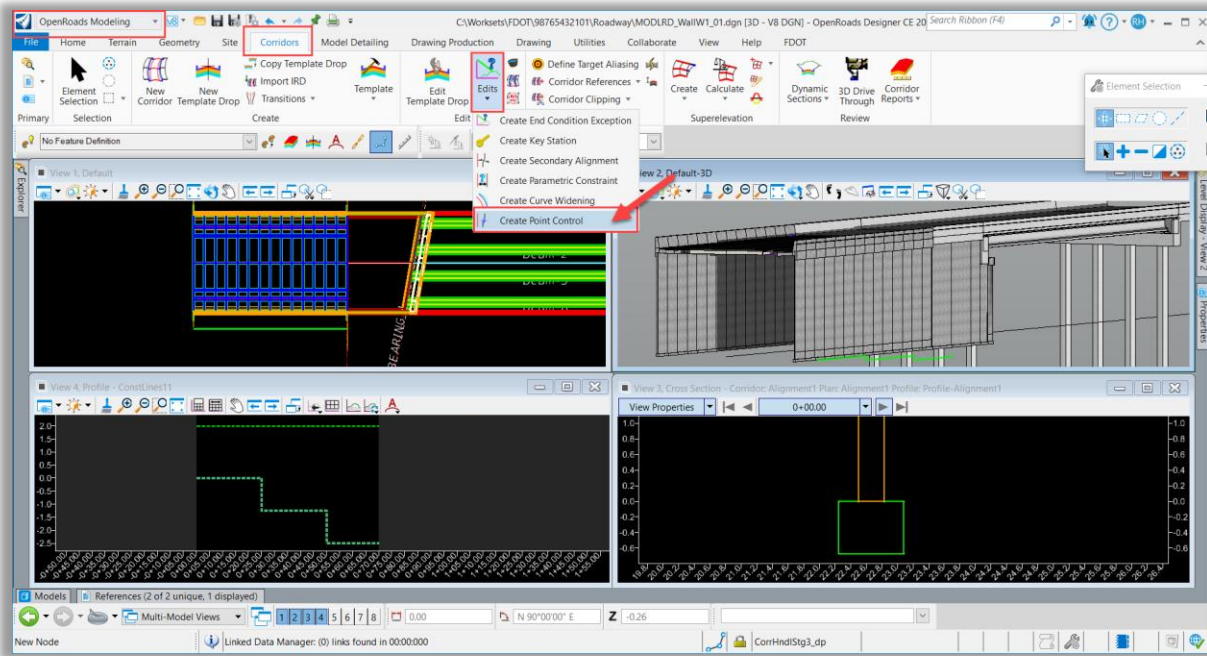


10. Review the Profile View and verify that the import was successful.



➤ **Apply New Profile to MSE Retaining Wall Leveling Pad:**

1. Apply a Point Control to the RT MSE Retaining Wall Corridor.



2. Enter the required information and follow the prompts to select the corridor, point, and reference profile.

Create Point Cont...

Parameters

Lock To Start

Start

Lock To End

Stop

Control Description RT MSE RET WALL

Point T_MSE_BACK_BOT_IN

Mode Vertical

Control Type Linear Geometry

Plan Element ConstLines11

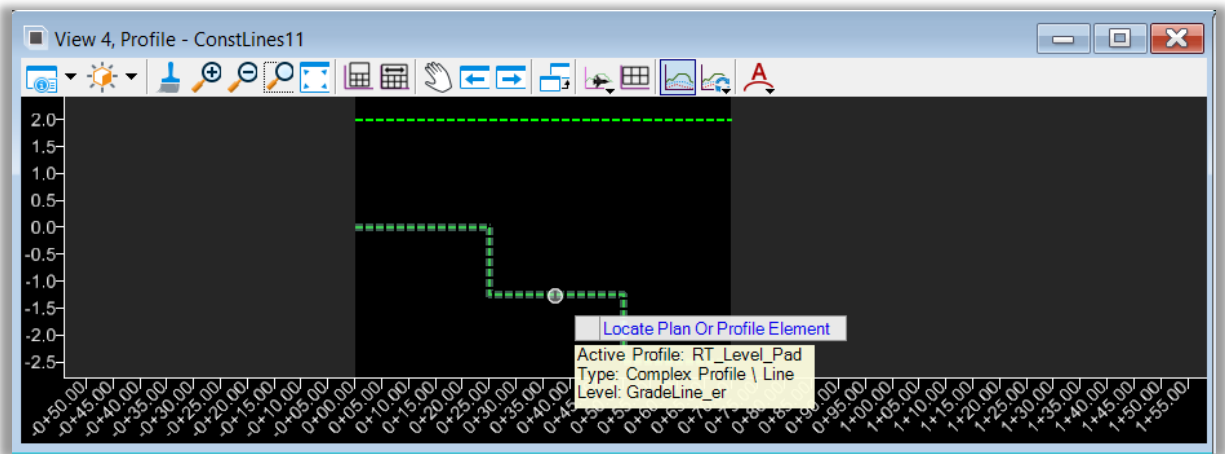
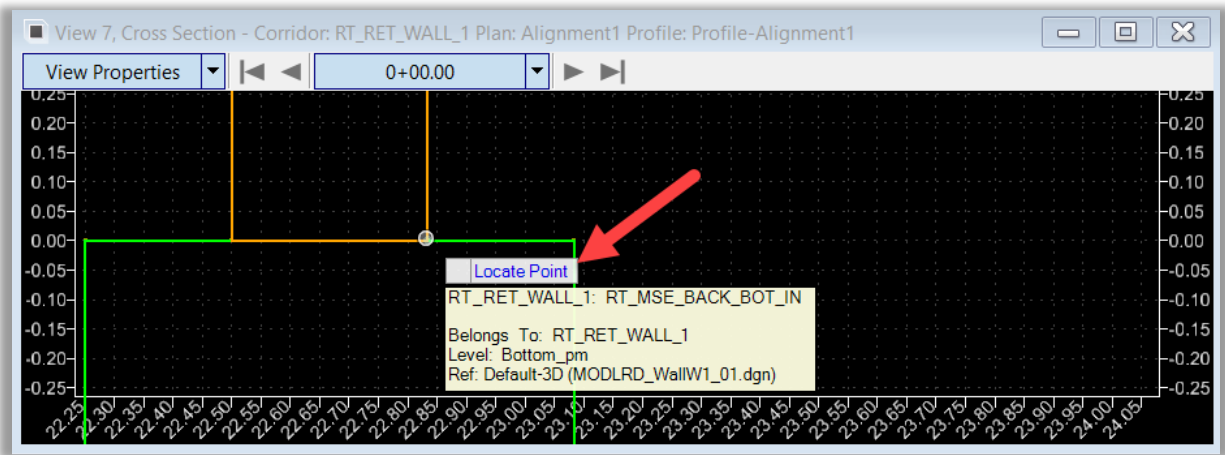
Profile Element Active Profile: RT_Level_P

Priority 1

Vertical Offsets

Start 0.00

Stop 0.00

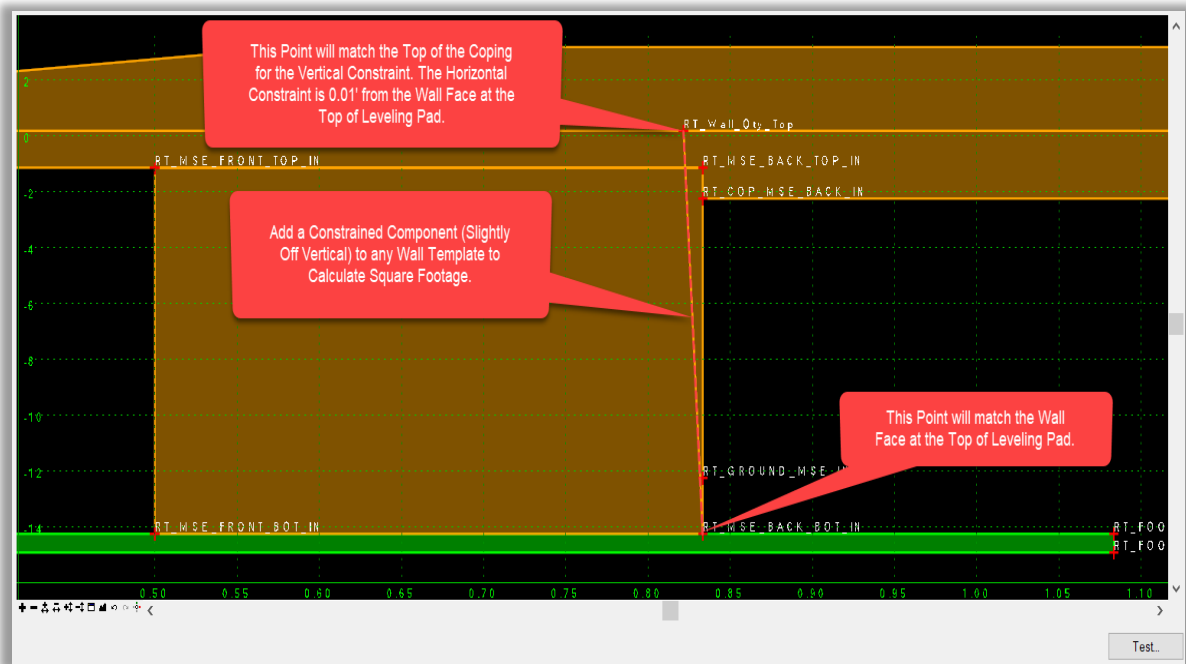


3. Review The Leveling Pad Profile in the 3D View.
4. Repeat the process for the LT MSE Retaining Wall Leveling Pad.

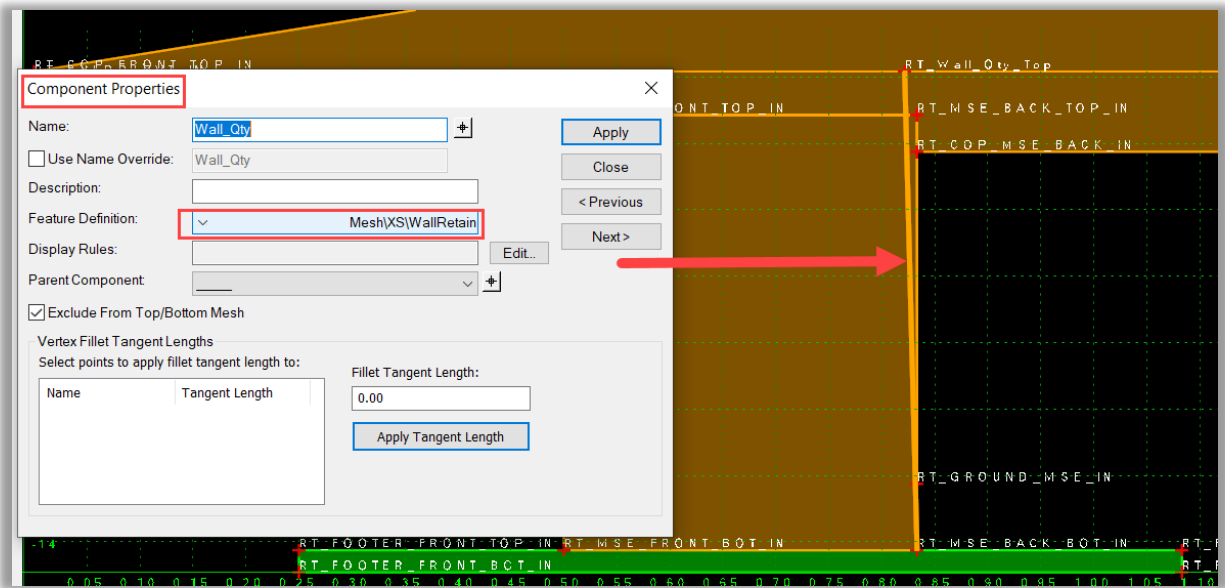
Exercise 1.4 Extract MSE Wall Quantities from Model Data

➤ Add Constrained Component to Calculate Square Footage:

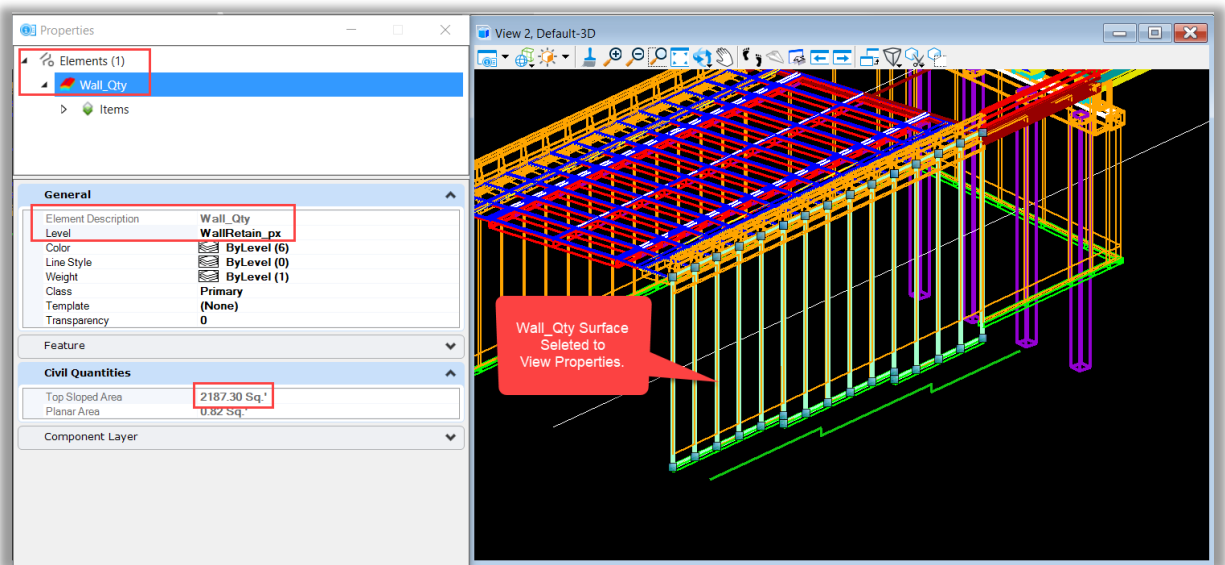
1. Add a Constrained Component (must be slightly off vertical) to any wall template to calculate square footage.
2. This example shows the New Component that will create a Mesh Surface from the Wall Face at the Top of Leveling Pad, to the Top of the Wall Coping, with a 0.01' offset to be slightly off vertical.



3. Review the Component Properties for the Wall Quantity Mesh as shown in the image below.



- Review the 3D View of the MSE Retaining Wall Corridor to analyze and note the Wall Quantity in Square Feet.



Note Automated Wall Quantities are under development and will be available in a future release of FDOTConnect.

Please refer to Bentley’s Coffee Corner: OpenRoads - Modeling Walls and Side Slopes (4061609) for more information on Wall Plan Production.

Please register at the link below to view:

https://event.on24.com/eventRegistration/EventLobbyServlet?target=reg20.jsp&eventid=2165505&sessionid=1&key=F7DE5FF1838FBF830B8E44F1510F43AE&groupid=759891&partnerref=EM_MULTIREG&sourcepage=register